

**DRAFT
AIR QUALITY MODELING REPORT
SNOWMOBILE AND SNOWCOACH EMISSIONS**

**WINTER USE PLAN
Environmental Impact Statement**

**YELLOWSTONE and GRAND TETON NATIONAL PARKS and the
JOHN D. ROCKEFELLER, JR., MEMORIAL PARKWAY**

Prepared for

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Air Quality Modeling Report
Winter Use Plan Environmental Impact Statement
Yellowstone and Grand Teton National Parks and the
John D. Rockefeller, Jr., Memorial Parkway

1.0 Introduction and Background

In support of the Winter Use Plan Preliminary Draft Environmental Impact Statement (PDEIS) for Yellowstone National Park (Yellowstone), Grand Teton National Park (Grand Teton), and the John D. Rockefeller, Jr. Memorial Parkway (Parkway), Air Resource Specialists, Inc. (ARS) completed an analysis of potential air quality impacts from snowmobile and snowcoach operations. This report analyzes potential air quality impacts for several preliminary alternatives utilizing air dispersion modeling and other accepted methods and models. Oversnow motorized vehicle entry limits and other details for each of the preliminary alternatives were provided by NPS to ARS and are discussed in section 3.0 and Appendix A.

This air quality study is part of the National Park Service's (NPS) efforts to complete a long-term analysis of the environmental impacts of winter use in the parks. Currently, the NPS is operating under the *Temporary Winter Use Plans Environmental Assessment* for Yellowstone and Grand Teton National Parks and the John D. Rockefeller, Jr., Memorial Parkway (hereinafter, the temporary plan). Based on this EA, the National Park Service published the temporary plan in the *Federal Register* implementing winter use rules on November 10, 2004. These rules are in effect through the winter of 2006-07.

The temporary plan currently allows 720 snowmobiles per day in Yellowstone, all commercially guided. In Grand Teton and the Parkway, 140 snowmobiles are allowed per day. Within Yellowstone, all snowmobiles must also meet Best Available Technology (BAT) requirements. Guides are not necessary in Grand Teton, but most machines there must also meet BAT requirements. The temporary plan is in effect for an interim period of three winters, allowing snowmobile and snowcoach use through the winter of 2006-2007. The assessment of preliminary alternatives analyzed in this study is based on implementation of the associated entry limits and BAT requirements under consideration in the PDEIS, and beginning during the winter season of 2007-2008, which determines emissions factors.

For this air quality study of oversnow motorized vehicle emissions in Yellowstone, Grand Teton, and the Parkway, maximum predicted ambient concentrations of carbon monoxide (CO) and particulate matter (PM₁₀ and PM_{2.5}) were calculated using U.S. Environmental Protection Agency (EPA) approved air quality models. Impacts for each preliminary alternative were assessed with respect to the National Ambient Air Quality Standards (NAAQS) and relative to current and historical conditions. Modeling results were also compared to Prevention of Significant Deterioration (PSD) increments for particulate matter, and potential visibility impacts for each preliminary alternative were assessed. Winter-season emission estimates for criteria pollutants (CO, PM, and

nitrogen oxides (NO_x), hydrocarbons (HC), and hazardous air pollutants (HAPs) (benzene, 1,3 butadiene, formaldehyde, and acetaldehyde) were calculated. The methodology employed for this study is discussed in the following sections and is also detailed in the Modeling Study Plan, which is included as Appendix J.

2.0 Regulatory Overview

Yellowstone and Grand Teton are classified as Class I areas under the Federal Clean Air Act. This air quality classification is to provide protection against air quality degradation in national parks and wilderness areas. The Clean Air Act defines mandatory Class I areas as national parks over 6,000 acres, wilderness areas over 5,000 acres, and national memorial parks over 5,000 acres designated as of the date of the Act. The Parkway is a Class II area but is managed as a Class I area according to NPS policy.

For this study, dispersion modeling was utilized to predict concentrations of CO and particulates (PM₁₀ and PM_{2.5}) for a short-term localized basis at specific locations in the parks. These predicted concentrations were assessed with respect to the NAAQS, which are discussed below, to determine the potential for air quality impacts. In addition, an emission inventory was completed for the four (4) pollutants discussed below to assess regional motorized oversnow vehicle emissions during the winter season. Also, as a Class I area, an analysis of potential visibility impacts resulting from oversnow vehicle emissions was conducted for four (4) areas. The methodology and results of this visibility analysis are presented in Section 8.0.

In 2002, EPA adopted new standards for new non-road engines, including snowmobiles, which were previously unregulated. As a significant source of air pollution, newly manufactured non-road engines will need to meet exhaust emission standards. For snowmobiles, the new HC and CO standards began to take effect for the 2006 model year, with a 50 percent phase-in requirement. Further details on these standards are provided below in Section 4.0.

2.1 Pollutants

Carbon monoxide (CO), a colorless, odorless, and poisonous gas, is produced in locations with motor vehicles, primarily by the incomplete combustion of gasoline and other fossil fuels. Health effects include impairment of the central nervous system, particularly on people with heart disease. CO also interferes with the transport of oxygen in the blood. In the vicinity of roadways, the majority, if not all, CO emissions are from motor vehicles. CO concentrations can vary greatly over relatively short distances. Elevated concentrations are usually limited to locations near crowded intersections, typically along heavily traveled and congested roadways.

Consequently, CO concentrations must be predicted on a localized or microscale basis. Elevated traffic volumes of snowmobiles and snowcoaches on certain park roadways could result in localized increases in CO levels. Therefore, the mobile source

analysis evaluated CO concentrations from snowmobiles and snowcoaches at several modeling locations within the parks.

Particulate matter (PM₁₀ and PM_{2.5}) is emitted into the atmosphere from a variety of sources: industrial facilities, power plants, construction activity, etc. Gasoline powered vehicles typically do not produce any significant quantities of particulate emissions; however, 2-stroke snowmobiles emit substantially more particulates than either 4-stroke snowmobiles or snowcoaches. Although less relevant to this study, diesel-powered vehicles, especially heavy trucks and buses, also emit particulates, and particulate concentrations may be locally elevated near roadways with high volumes of heavy diesel-powered vehicles. The mobile source analysis evaluated particulate (PM₁₀ and PM_{2.5}) concentrations from snowmobiles, snowcoaches, and diesel buses (for one alternative) at several modeling locations within the parks.

Hydrocarbon (HC) emissions from motor vehicles can result from partially-burned fuel emitted through the tailpipe and from fuel evaporations from the crankcase, carburetor and gas tank. Hydrocarbons are also released from gasoline fuel vapor when vehicles are re-fueled at gas stations and when bulk storage tanks are refilled. When exposed to sunlight, hydrocarbons or volatile organic compounds (VOCs) contribute to formation of harmful ground level ozone, also known as smog. For the purposes of this study, hydrocarbons may also be expressed as VOCs, which include air toxins or hazardous air pollutants (HAPs). Within the parks, these pollutants are of primary concern due to their potential serious health effects on NPS workers and visitors.

Air toxins or HAPs associated with motor vehicles also result from fuel evaporation and the fuel-burning process. These pollutants include a variety of chemicals known to cause cancer, poisoning and other ailments. The emission inventory completed for this study included hydrocarbon emissions as well as the following HAPs: benzene; 1,3 butadiene; formaldehyde; and acetaldehyde.

Nitrogen oxides (NO_x), are typically of principal concern because of their role as precursors in the formation of photochemical oxidants, such as ozone. Ozone is formed through a series of reactions that take place in the atmosphere in the presence of sunlight. However, ozone is not an issue in the parks in the winter, although NO_x also contributes to atmospheric particles, and can cause respiratory problems and visibility impairment. NO_x emissions from mobile sources and the pollutants formed from NO_x can be transported over long distances, so they are generally examined on a regional basis and are assessed in the emission inventory component of this study.

2.2 Air Quality Standards

As required by the Clean Air Act and its amendments, the Environmental Protection Agency has established primary and secondary National Ambient Air Quality Standards (NAAQS) for six major air pollutants: CO, NO₂, ozone, particulate matter (PM₁₀ and PM_{2.5}), SO₂, and lead. The NAAQS of primary concern for this analysis (CO, PM₁₀ and PM_{2.5}) are shown in Table 2-1.

Table 2-1
National Ambient Air Quality Standards

Pollutant	Primary		Secondary	
	PPM	Micrograms Per Cubic Meter	PPM	Micrograms Per Cubic Meter
Carbon Monoxide (CO)				
Maximum 8-Hour Concentration ¹	9		None	
Maximum 1-Hour Concentration ¹	35			
Respirable Particulates (PM₁₀)				
Annual Arithmetic Mean ²		50	Same as Primary	
Maximum 24-Hour Concentration ¹		150		
Respirable Particulates (PM_{2.5})				
Annual Arithmetic Mean ³		15	Same as Primary	
Maximum 24-Hour Concentration ⁴		65		
Notes:				
¹ Not to be exceeded more than once per year.				
² To attain this standard, the 3-year average of the weighted annual mean PM ₁₀ concentration at each monitor within an area must not exceed 50 ug/m ³ .				
³ To attain this standard, the 3-year average of the weighted annual mean PM _{2.5} concentrations from single or multiple community-oriented monitors must not exceed 15.0 ug/m ³ .				
⁴ To attain this standard, the 3-year average of the 98 th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 65 ug/m ³ .				
PPM = parts per million				
Source: 40 CFR Part 50—National Primary and Secondary Ambient Air Quality Standards				

The primary standards protect public health, and represent levels at which there are no known significant effects on human health. The secondary standards are intended to protect the nation's welfare, and account for air pollutant effects on soil, water, visibility, materials, vegetation, and other aspects of the environment. For CO, PM₁₀ and PM_{2.5}, the primary and secondary standards are the same.

Impacts for each preliminary alternative were assessed with respect to the NAAQS and relative to current and historical conditions. For Wyoming, Montana, and Idaho, the applicable state standards for CO and particulates are the same as the federal standards, with the exception of the 1-hour CO standard in Montana, which is 23 ppm.

Since Yellowstone and Grand Teton are classified as Federal Class I areas, PM₁₀ increment comparison under PSD were also assessed. PSD increments are the maximum permitted increases in pollutant concentrations over baseline levels. For Class I areas, the PM₁₀ PSD increments are 4 and 8 micrograms per cubic meter, for the annual and 24-hour averaging periods, respectively. Winter oversnow vehicle emissions were considered increment consuming or contributing sources for this analysis. This study

only assessed PSD increments for the 24-hour averaging period, since the sources of concern are only present during the winter season and an applicable annual average cannot be prepared. This assessment is a screening level approach and may indicate that a detailed analysis is required if concentrations are near the PM₁₀ PSD increments. Furthermore, as the methodology employed in this study is a screening-level analysis, it is not intended for regulatory purposes and does not constitute a regulatory PSD increment consumption analysis.

2.3 Air Quality Monitoring

In recent years, ARS has been contracted by NPS to conduct winter air quality monitoring in Yellowstone near the Old Faithful geyser. Meteorological, gaseous, and particulate variables were monitored continuously. The Montana Department of Environmental Quality (DEQ) also collects meteorological, gaseous, and particulate data at a monitoring station at the West Entrance to Yellowstone.

The most recent monitored CO and PM_{2.5} concentrations at these locations can be found in the *Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005*, Air Resource Specialists, August 2005. At the West Entrance monitor, the highest CO 1- and 8-hour averages in 2004-2005 were 2.8 and 1.0 ppm, respectively. The highest CO 1- and 8-hour averages were 1.7 and 0.8 ppm, respectively, at the Old Faithful monitor for 2004-2005. These were well below the respective 1- and 8-hour CO NAAQS (35 and 9 ppm), Montana and Wyoming air quality standards. Similarly, the highest PM_{2.5} 24-hour average in 2004-2005 was 6.0 micrograms per cubic meter at the Old Faithful monitor and 9.5 micrograms per cubic meter at the West Entrance monitor, which were well below the PM_{2.5} NAAQS of 65 micrograms per cubic meter for the 24-hour averaging period.

Since monitoring began in 1998 for CO and in 2002 for PM_{2.5} at Yellowstone, measured pollutant concentrations have steadily decreased, consistent with the decrease in number of snowmobile visits and the recent snowmobile technology emission requirements under the temporary plan. As documented in the *Winter Air Quality Study 2004-2005*, John D. Ray, Ph.D., NPS Air Resources Division, December 2005, at the West Entrance, the highest measured 8-hour average CO concentrations have gone from a near NAAQS exceedance of 8.9 ppm in the 1998-1999 winter season to 1.0 ppm in 2004-2005. At Old Faithful, the highest measured 8-hour average CO concentrations have declined from 1.2 ppm in the 2002-2003 winter season to 0.6 ppm in 2004-2005.

Similarly, the highest measured 24-hour average PM_{2.5} concentrations at the West Entrance have declined from 18.6 micrograms per cubic meter in the 2002-2003 winter season to 6.0 micrograms per cubic meter in 2004-2005. At Old Faithful the highest measured 24-hour average PM_{2.5} concentrations have declined from 32.1 micrograms per cubic meter in the 2002-2003 winter season to 4.0 micrograms per cubic meter in 2004-2005. These monitored maximum values demonstrate a distinct trend of improvement in winter pollutant concentrations in Yellowstone. A summary of all monitored data discussed above can be found in the above referenced NPS report.

Modeling results from this study will also be compared with the monitoring data collected at the West Entrance and Old Faithful sites for historical conditions (1999, with 1983 Regulations) and current conditions scenarios.

3.0 Preliminary Alternatives

Oversnow motorized vehicle entry limits and other details of the preliminary alternatives required as inputs for the air quality modeling and emission inventory were provided by the National Park Service (NPS). Descriptions of the six (6) preliminary alternatives are provided in Table 3-1, and the four (4) options for Preliminary Alternative 1 are shown in Table 3-2. (It should be noted that although snowmobile entry limits for Cave Falls Road are provided for the preliminary alternatives, this short roadway segment, approximately only a mile in length within Yellowstone, would be a minor contribution to overall park-wide emissions and therefore, was not included in the emissions inventory.) In addition, *The Motorized Oversnow Vehicle Scenarios* document and *New Commercial Guide Scenarios With Exit Factors* spreadsheets are included as Appendix A of this report. Although the methods used to develop the new scenarios and general assumptions are discussed in detail in the appendix, a summary of the development of modeling scenarios analyzed in this study follows.

The development of a model to distribute use within the parks, based on the entrance limits specified under each preliminary alternative, is necessary in order to understand the impacts of the alternatives on park resources and values. These models, called travel factors, were developed in the past for the Temporary Winter Use EA, the SEIS, and the EIS. The scenarios attempt to predict the total amount of daily winter recreational (motorized) traffic on each road segment within Yellowstone and Grand Teton National Parks, by vehicle type.

The scenarios provide both a sense of how much snowmobile or snowcoach traffic one can expect in a day on each road segment within the parks and a comparison of the relative differences among the preliminary alternatives. This approach facilitates an understanding of the magnitude of differences of the environmental consequences of each preliminary alternative. The preliminary alternatives also provide fundamental air quality inputs to the modeling analyses.

For the development of the new long-term EIS, the travel scenarios were updated from those used for the Temporary EA for two major reasons. First, park managers and partners recognized that commercially guided trips may have different visitation patterns than unguided groups. Thus, there could be differences in the travel and visitation patterns for guided vs. unguided (or non-commercially guided) groups. The updated modeling data and travel factor spreadsheets account for differences in the travel characteristics of snowmobiles based on whether commercial guides are required for each particular alternative.

**Table 3-1
Summary of Preliminary Alternatives**

	Alternative 1: Current Plan	Alternative 2: Snowcoaches Only	Alternative 3: Eliminate Most Road Grooming	Alternative 4: Enhanced Recreational Use	Alternative 5: Provide for Unguided Access	Alternative 6: Mixed Use
Highlights	Allows for nearly historic levels of snowmobile use but requires commercial guides. This Alternative mimics the temporary winter use plan currently in place, with three primary changes: 1) Snowcoaches must meet BAT standards; 2) Daily limit on snowcoaches; and 3) Sylvan Pass is closed to through travel under 3 of 4 options for this Alternative (see Table 3-2).	Emphasizes snowcoach access; prohibits recreational snowmobiling. Road grooming would continue.	Prohibits road grooming or packing on most road segments in Yellowstone National Park. The road from the South Entrance to Old Faithful would be the only oversnow motorized access route Yellowstone.	Allows for increased snowmobile use, relative to historic numbers. Commercial guides would be required for most snowmobilers; some could also visit the park after completing a non-commercial or unguided guide training course.	Balances snowmobile and snowcoach access and accommodates some visitors who wish to have an unguided snowmobile experience. Features a seasonal limit as well as a flexible daily limit	Emphasizes plowing Yellowstone's lower elevation, west-side roads to allowed wheeled commercial vehicle access. Continue to allow oversnow vehicle access through the South Entrance and on the east side of the park.
Daily Snowmobile Limits in YNP	720 snowmobiles per day West: 400 South: 220 North: 30 East: 40 Old Faithful: 30 Cave Falls Road: 50 snowmobiles (no BAT or guiding)	Snowmobiles prohibited. Cave Falls Road closed to snowmobiles	South: 250 snowmobiles per day. Cave Falls Road closed to snowmobiles	1,025 snowmobiles per day West: 600 South: 250 North: 25 East: 100 Old Faithful: 50 Cave Falls Road: 75 snowmobiles (no BAT or guiding)	540 snowmobiles per day West: 290 South: 145 East: 40 North: 40 Old Faithful: 25 Cave Falls Road: 50 snowmobiles (no BAT or guiding) Seasonal entry limit would be put in place: no more than 27,540 snowmobiles and 5,291 snowcoaches per season in YNP. Daily commercial snowmobile and snowcoach entries could exceed above limits by 20% on busy days (up to 518 commercial snowmobiles and 100 snowcoaches) per day, but such entries would count against seasonal limit above.	350 snowmobiles per day South: 250 Old Faithful/Norris: 100 100 wheeled vehicles Cave Falls Road: 50 snowmobiles (no BAT or guiding)

**Table 3-1
Summary of Preliminary Alternatives**

	Alternative 1: Current Plan	Alternative 2: Snowcoaches Only	Alternative 3: Eliminate Most Road Grooming	Alternative 4: Enhanced Recreational Use	Alternative 5: Provide for Unguided Access	Alternative 6: Mixed Use
Daily Snowmobile Limits in GTNP and Parkway	140 snowmobiles per day Grassy Lake Rd: 50 CDST: 50 Jackson Lake: 40	Snowmobiles prohibited	Grassy Lake Rd: 50 CDST: Closed Jackson Lake: Closed	250 snowmobiles per day. Grassy Lake Rd: 75 CDST: 75 Jackson Lake: 100	140 snowmobiles per day Grassy Lake Rd: 50 CDST: 50 Jackson Lake: 40 All would be improved BAT.	90 snowmobiles per day. Grassy Lake Road: 50 Jackson Lake: 40 CDST: Closed.
Snowmobile Guide Requirements	YNP: 100% Commercially guided. GTNP and Parkway: Guides not required.	N/A	YNP: 100% Commercially guided. GTNP and Parkway: Guides not required.	YNP: 75% commercially guided; 25% either unguided or non-commercially guided. GTNP and Parkway: CDST: 50 commercially guided; 25 unguided. Jackson Lake and Grassy Lake Road: unguided	YNP: 80% commercially guided 20% unguided, with brief training. Unguided snowmobiles would be required to enter YNP prior to 10:30AM. GTNP and Parkway: Commercial guides may be allowed, but not required.	YNP: 100% commercially guided, both oversnow and wheeled vehicles. GTNP and Parkway: Commercial guides may be allowed, but not required.
Best Available Technology Requirements for Snowmobiles	YNP: All BAT. GTNP and Parkway: All BAT, except snowmobiles originating on Targhee NF using Grassy Lake Road.	N/A	YNP: All BAT. GTNP and Parkway: All BAT, except snowmobiles originating on Targhee NF using Grassy Lake Road.	YNP: all BAT. GTNP and Parkway: Jackson Lake: All BAT. Grassy Lake Road: All Non-BAT. CDST: 50 commercially guided BAT; 25 unguided 2006 model year or newer.	Improved BAT for snowmobiles (95% reduction in HC and 75% reduction in CO; NTE 72dBA), except snowmobiles originating on Targhee NF using Grassy Lake Road.	YNP: All BAT. GTNP and Parkway: All BAT, except snowmobiles originating on Targhee NF using Grassy Lake Road.
Maximum Snowmobile Group Size	8 with one guide; 17 with 2 guides	N/A	11 with one guide.	11 with one guide	11 with one guide	8 with one guide; 17 with 2 guides

**Table 3-1
Summary of Preliminary Alternatives**

	Alternative 1: Current Plan	Alternative 2: Snowcoaches Only	Alternative 3: Eliminate Most Road Grooming	Alternative 4: Enhanced Recreational Use	Alternative 5: Provide for Unguided Access	Alternative 6: Mixed Use
Use of YNP Side Roads by Snowmobiles	Washburn Overlook and Freight Road: snowcoach only. Firehole Canyon Drive, Canyon North Rim Drive and Riverside Drive: open in <u>afternoon</u> to snowmobiles. Lake Butte and Canyon South Rim: open to snowmobiles. Virginia Cascades: ski only.	Virginia Cascades: ski only. All other side roads: snowcoach only	All closed (there are none on the road from South Entrance to Old Faithful).	All side roads open to snowmobiles. Virginia Cascades: ski only.	Washburn Overlook and Freight Road: snowcoach only. Firehole Canyon Drive, Canyon North Rim Drive and Riverside Drive open in <u>afternoon</u> to snowmobiles. Lake Butte and Canyon South Rim open to snowmobiles. Virginia Cascades ski only.	Canyon North and South Rim Drives, Lake Butte: Open to snowmobiles. Firehole Canyon, Riverside Drive, Fountain Freight Road, Washburn Hot Springs: Snowcoach only. Virginia Cascades: ski only.
Daily Snowcoach Limits in YNP and Snowcoach BAT	78 snowcoaches per day West: 34 South: 13 North: 13 East: 0 Old Faithful /Parkwide: 18 All meet snowcoach BAT	120 snowcoaches per day West: 55 South: 25 North: 17 East: 0 Old Faithful /Parkwide: 23 All meet snowcoach BAT	South: 20 All meet snowcoach BAT	115 snowcoaches per day West: 46 South: 15 North: 5 East: 4 Old Faithful /Parkwide: 35 Private: 10 All meet snowcoach BAT	83 snowcoaches per day West: 34 South: 10 North: 3 East: 2 Old Faithful /Parkwide: 34 All meet snowcoach BAT. Seasonal entry limit would be put in place.	40 snowcoaches per day South: 10 Old Faithful/Norris: 30 All meet snowcoach BAT.
Road Grooming	Continue road grooming, except Sylvan Pass would be closed.	Continue road grooming, except Sylvan Pass would be closed.	Only groom South to Old Faithful. All other segments ungroomed and closed to oversnow travel.	Continue road grooming	Continue road grooming	Plow Mammoth to West to Old Faithful. Groom Old Faithful to South to Lake to Canyon to Norris. Sylvan Pass would be closed.

**Table 3-2
Preliminary Alternative 1 Options**

Option	Option A		Option B		Option D		Option E	
Description	With East Entrance Open		With East Entrance Closed		With East Entrance Closed and Overall Snowmobile Numbers Reduced by 40 Entries		With Gibbon Canyon and East Entrance Closed and Overall Snowmobile Numbers Reduced by 40 Entries	
Entrance	Commercially Guided Snowmobiles	Commercially Guided Snowcoaches	Commercially Guided Snowmobiles	Commercially Guided Snowcoaches	Commercially Guided Snowmobiles	Commercially Guided Snowcoaches	Commercially Guided Snowmobiles	Commercially Guided Snowcoaches
West Entrance	400	34	424	34	400	34	400	34
South Entrance	220	10	256	13	220	13	220	13
East Entrance	40	3	0	0	0	0	0	0
North Entrance	30	13	20	13	30	13	30	13
Old Faithful	30	18 (Parkwide)	20	18 (Parkwide)	30	18 (Parkwide)	30	18 (Parkwide)
Total	720	78	720	78	680	78	680	78

Second, the earlier modeling scenarios only included in-bound traffic within Yellowstone and did not include traffic exiting the park (i.e., return trips were not “counted” by the previous modeling as traveling on road segments a second time). Since this potentially excluded a substantial amount of traffic, this was corrected in the update and the latest travel factor spreadsheets include both in-bound and out-bound trips for all alternatives.

In addition to the six (6) preliminary alternatives analyzed in this report, two (2) additional modeling scenarios were also analyzed for comparison. These are the Current Conditions and the 1999 Historical Unregulated Conditions Scenarios. Details on these modeling scenarios are provided in Appendix A.

4.0 Mobile Source Modeling

Estimates of maximum concentrations for pollutant averaging periods were prepared to compare with the national ambient air quality standards (which are based on 1- and 8-hour averages for CO concentrations and 24-hour averages for particulate concentrations). The prediction of CO, PM₁₀ and PM_{2.5} concentrations generated by over-snow vehicles takes into account emissions data, meteorological phenomena, vehicle traffic/travel conditions, and physical configurations (of roadways and staging areas). The mathematical formulations that comprise the dispersion and emission models attempt to simulate the extremely complex physical phenomenon as closely as possible. Although most dispersion models are typically conservative, especially under adverse meteorological conditions, the results of the modeling below compared with monitored concentrations show predicted concentrations within the reasonable in range of possibility, considering that all models must employ approximations of actual conditions.

The analysis employs a modeling approach widely used for evaluating air quality impacts throughout the country. This approach was coupled with a series of conservative assumptions for meteorology, traffic conditions, background concentration levels, etc. This combination results in conservative, yet realistic, estimates of expected pollutant concentrations and resulting potential impacts to air quality from the winter use vehicle emissions.

4.1 Dispersion Modeling

Air dispersion modeling analyses were conducted for emissions of CO, PM₁₀, and PM_{2.5} employing EPA’s CAL3QHC and Industrial Source Complex Short Term (ISCST3) models. The models and modeling inputs, parameters, and assumptions, along with emission factors are discussed in detail below.

4.1.1 CAL3QHC

At the entrance stations and roadways selected for study, analysis was performed using EPA’s CAL3QHC model (*User’s Guide to CAL3QHC, A Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections*, Office of Air Quality, Planning Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina). The CAL3QHC model is based on the CALINE-3 line source

dispersion model, with an additional algorithm for estimating vehicle queue lengths at signalized intersections. It is a Gaussian model utilized for predicting CO and PM concentrations along roadway segments and assumes the dispersion of pollutants downwind of a pollution source along a Gaussian (or normal) distribution. The pollution source is the emissions from motorized vehicles operating under free flow conditions.

CAL3QHC provides the refinement of including the contribution of emissions from idling vehicles in the overall concentration. The model's queuing algorithm requires additional input for local traffic parameters, such as signal timing, and performs delay calculations to estimate the number of idling vehicles. In this study, locations with snowmobiles and snowcoaches stopping and idling were simulated with the characteristics of a signalized intersection for CAL3QHC modeling.

4.1.2 ISCST3

Air pollutant concentrations from emissions at the snowmobile staging areas were evaluated with the Industrial Source Complex, Short Term dispersion model, Version 3 (ISCST3), developed by EPA and described in the *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models* (EPA-454/B-95-003a). Since vehicles in staging areas are clustered (in the parking lots), the ISC3 model was selected, utilizing its area source dispersion modeling capabilities. All ISCST3 technical options selected followed the *regulatory default option*, and included:

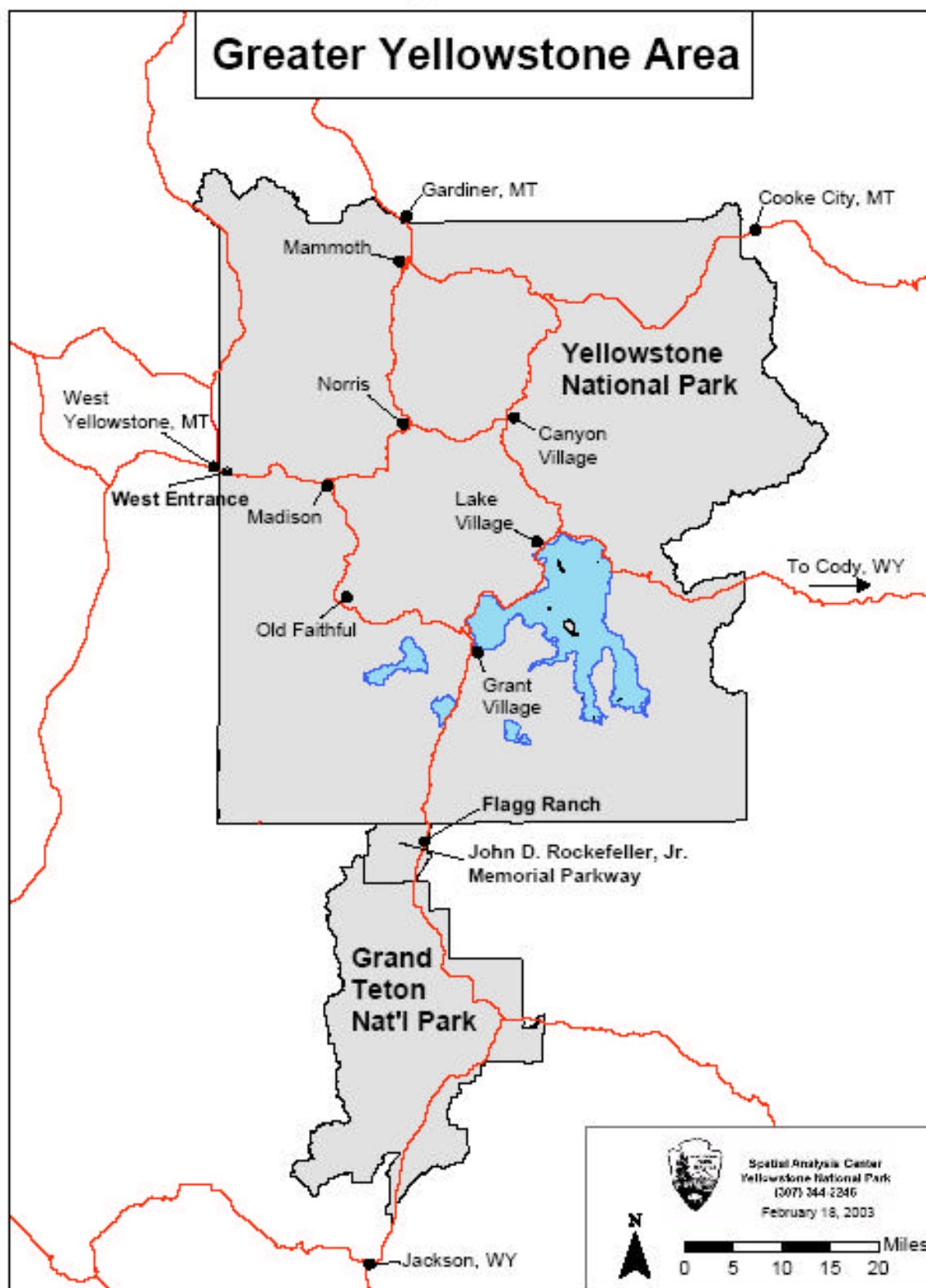
- Buoyancy-induced dispersion
- Final plume rise
- Calms processing
- Default wind speed profile exponents and vertical temperature gradient

Model inputs also specified rural conditions for dispersion coefficients and other variables. Due to the geography of the area, as with prior modeling analyses performed in Yellowstone, terrain data were not used. It was assumed that elevation differences at the staging areas and surrounding areas would not result in any significant impact. As such, the terrain option was omitted.

4.2 Modeling Locations

Four (4) locations in the parks were selected for air quality modeling because they were expected to generate the most elevated ambient air quality impacts associated with snowmobile and snowcoach operations, due to expected vehicle traffic levels. These locations (shown on Figure 4-1) are: Yellowstone's West Entrance, West Entrance to Madison Junction, Old Faithful Staging Area, and the Flagg Ranch Staging Area (in the Parkway). At the roadway modeling locations, multiple receptors (computer simulations of roadside locations) were modeled for CAL3QHC along the approach and departure links at spaced intervals, outside of the mixing zone, the area of uniform emissions and turbulence. Ground-level receptors were set at a default height of 6 feet. The receptor with the highest predicted concentration was used to represent each modeling site for each preliminary alternative or scenario.

Figure 4-1



West Entrance

The West Entrance is a unique location for modeling as snowmobiles and snowcoaches approach the entrance station and then stop for a short time while entrance permits are checked. Vehicles experience delay and queuing traffic conditions. In addition, this location is in close proximity to West Yellowstone, MT. Modeling was performed based on an average approach and departure speed of 15 miles per hour (mph) and an average engine idle time of 30 seconds at each kiosk. The approach and departure paths of the vehicles were simulated by line sources or “links”, up to 1,000 feet in each direction from the West Entrance. CAL3QHC modeling was performed for this intersection-type location.

At the West Entrance modeling location, receptors were spaced oppositely in each direction out from a central receptor placed at the origin of the queuing links, with receptors placed in pairs on each side of the links. Receptors were placed 3 feet both east and west (lengthwise) of the central receptor; the next pair of receptors were placed 25 feet from the central receptor. The remaining receptors were placed at intervals of 25 feet out to a distance of 500 feet along the link.

West Entrance to Madison

For many of the preliminary alternatives, this modeling location is expected to have the highest traffic volumes compared to other roadway segments in Yellowstone, Grand Teton, and the Parkway. This is expected to result in elevated emissions and associated impacts from snowmobile and snowcoach traffic. CAL3QHC modeling was performed for the free-flow roadway segments of this location, employing emissions data for snowmobiles traveling at 35 to 45 mph (see discussion of modes below). In winter, the speed limit for this road segment is 35 mph, whereas the limit is 45 mph for most of the park. As discussed above, vehicle traffic levels were based on the proposed entry limits in the winter use plan for each preliminary alternative.

For the West Entrance to Madison location, receptors were spaced along 2000 feet of the straight portions of the links. For the middle section of this modeling location, a gradual curve in the roadway geometry could result in potential overlapping emission contributions from roadway link segments at some modeling wind directions. Therefore, along these links, receptors were placed in pairs at intervals of 5, 25, 25, 50, 200, 200, 1500, and 1500 feet in both directions from the central receptors at the apex of the curve. As at the West Entrance, receptors were placed in pairs on each side of the links.

Old Faithful and Flagg Ranch Staging Areas

The Old Faithful and Flagg Ranch staging areas were selected for modeling because of the concentration of emissions from snowmobiles and snowcoaches bringing visitors to the Old Faithful Geyser Basin and parking area, and Flagg Ranch (in the Parkway). The primary contributor of emissions is the idling of engines after visitors enter and also prior to leaving these staging areas.

At the staging areas, emissions are clustered in distinct areas (the parking lots). Therefore, the ISC3 model was selected for area source modeling. Emissions at the staging area were calculated only for engine idling, which is assumed to be a total of five minutes on average for each vehicle, including during arrival and before departure. Engine emission calculations for the staging area did not explicitly include ingress and egress emissions from the vehicles, as these were included in the roadway segment emissions. It was conservatively assumed that all vehicles traveling from Madison and West Thumb to Old Faithful would enter the Old Faithful staging area and that all vehicles traveling to Yellowstone's South Entrance would enter the Flagg Ranch staging area, to maximize the number of vehicles included in the modeling for these sites.

The Old Faithful staging area, including the three (3) main parking areas, was modeled as a 630 meter by 1037 meter rectangular area source for ISC3 modeling, aligned north-south. The Flagg Ranch staging area, with two (2) parking areas, was modeled as a 60 meter by 165 meter rectangular area source for ISC3 modeling, also aligned north-south. These dimensions were confirmed by Yellowstone staff.

At the staging areas, a grid network of receptors was modeled for ISC3 along the perimeters of the area sources representing idling vehicles. Receptors were arranged in rectangular grids surrounding the Old Faithful and Flagg Ranch staging areas. At Old Faithful, receptors were placed at 100 meter intervals around the perimeter of the staging area out to approximately 1.5 kilometers in both the east and west directions, and out to approximately 2.0 kilometers in both the north and south directions. At Flagg Ranch, receptors were placed at 25-meter intervals around the perimeter of the staging area out to approximately 250 meters from the perimeter; at 50-meter intervals from the 250 meter boundary out to approximately 1.0 kilometer; at 100 meter intervals from the 1.0 kilometer boundary out to approximately 2.0 kilometers. Receptors were set at a default height of 6 feet.

4.3 Vehicle Emissions Data

To predict ambient concentrations of pollutants generated by vehicular traffic, emissions from vehicle exhaust systems must be estimated accurately. This analysis focuses primarily on emissions associated with visitor use of snowmobiles and snowcoaches and does not address other snowmobile use or other modes of vehicle travel within the park. However, Preliminary Alternative 6 would provide guided visitor access by on-road vehicles, by plowing Yellowstone's west-side roadways. Administrative vehicles are not included in any of the modeling. In general, the alternatives to be analyzed include only visitor snowmobile and snowcoach travel.

Emissions data and vehicle usage data (discussed below) were used for atmospheric dispersion modeling analyses to calculate the ambient levels of CO, PM₁₀, and PM_{2.5} at four (4) locations within the parks, for the preliminary alternatives. Emissions data will also be utilized to predict the total winter-season emissions of CO, PM, NO_x, HC, and HAPs due to the operations of snowmobiles and snowcoaches in the park. The data to be employed for this analysis were obtained from past air quality and emissions testing, research studies, as well as from vehicle manufacturers. Snowmobile laboratory test data utilized below may not reflect actual operating conditions in

Yellowstone, Grand Teton, and the Parkway, as high altitude and low winter temperatures in the parks are likely to decrease overall snowmobile engine performance and increase relative emissions. However, this data is the best available.

For the 1999 Historical Conditions Scenario (1983 Regulations), the air quality analysis assumed that all snowmobiles were 2-stroke engines (see the next paragraph for a discussion of EPA 2-stroke emissions regulations). Therefore, for this modeling scenario, the analysis assumed no snowmobile BAT requirements, replicating historic, unregulated conditions. For most preliminary alternatives, the analysis assumed that all snowmobiles are 4-stroke engines meeting NPS Best Available Technology (BAT) requirements (or better, in some alternatives, as defined below). Current BAT for snowmobiles operating in Yellowstone, Grand Teton, and the Parkway has been established for CO and HC emissions, at less than 120 and 15 grams per kilowatt hour, respectively. NPS is also considering implementing an “improved” snowmobile BAT requirement of less than 79 and 3.2 grams per kilowatt hour for CO and HC, respectively. This “improved” snowmobile BAT requires lower CO and HC emissions than the current BAT and is being considered by NPS to further reduce overall snowmobile emissions in the parks. Additional information on “improved” BAT for snowmobiles is provided below. Current and “improved” BAT requirements are shown in Table 4-1.

Table 4-1
Snowmobile BAT Requirements and EPA Standards

	Emission Requirement or Standard		Phase-in*
	Hydrocarbons (HC) (g/KW-hr)	Carbon Monoxide (CO) (g/KW-hr)	
NPS BAT	15	120	-
Proposed “Improved” BAT	3.2	79	-
EPA Emission Standards			
Model Year			
2006	100	275	50%
2007-2009	100	275	100%
2010	75	275	100%
2012	75	200	100%
Note: Improved BAT based on testing from SwRI’s <i>Laboratory Testing of Snowmobile Emissions</i> , Lela and White, July 2002. * Percent of newly manufactured sleds for the model year that must meet the applicable requirement.			

In addition, EPA adopted new standards for new non-road engines in 2002. For snowmobiles, the new standards will begin to take effect for the 2006 model year, with a 50 percent phase-in requirement. These standards and the corresponding implementation years are also provided in Table 4-1. Since they are less stringent than NPS BAT

requirements, EPA standards would only be applicable (for modeling purposes) to the analysis of the 1999 Historical Conditions scenario, and to some snowmobiles that enter the Parkway from Targhee National Forest, via Grassy Lake Road. For these situations, the 2-stroke vs. 4-stroke mix was determined based on replacement rates and future mix estimates in the Final Regulatory Support Document (EPA420-R-02-022) for EPA's *Final Rule for Cleaner Large Industrial Spark-Ignition Engines, Recreational Marine Diesel Engines, and Recreational Vehicles* (published November 8, 2002). Details on the mix of snowmobiles under these conditions (Preliminary Alternative 4 and 1999 Historical Conditions scenario) can be found in Appendix H.

All 2-stroke engine emission factors are based on the average emissions data from snowmobiles tested by the equipment manufacturer or by the Southwest Research Institute (SwRI). 4-stroke engine emission factors are based on manufacturers' EPA certification modal emission testing results. These snowmobile emission factors were previously presented in the *Temporary Winter Use Plans Environmental Assessment*, National Park Service, August 2004, although some minor revisions were made for this study. Composite emission factors for each preliminary alternative were calculated by weighting the snowmobile and snowcoach emission factors appropriate for each particular preliminary alternative according to usage levels of each vehicle type. These composite emission factors (weighted averages) were inputted to the CAL3QHC modeling.

4.3.1 2-Stroke Snowmobile Emission Factors

Emission factors for 2-stroke snowmobiles were calculated based on tests performed by SwRI (*Emissions from Snowmobile Engines Using Bio-Based Fuels and Lubricants*, Southwest Research Institute, October 1998). Emission testing and engine performance were measured during modal engine tests following standard EPA test procedures. 2-stroke snowmobile emission factors for CO and HC are calculated from engine horsepower output, in grams per mile for traveling vehicles and in grams per hour for idling vehicles. These calculations were made with information from the SwRI report, which was prepared for the State of Montana Department of Environmental Quality.

The SwRI modal testing obtained data for five (5) varying modes of operation. Mode 5 (a slow engine speed) approximates conditions when an engine is idling. Mode 4 (a moderate engine speed) is representative of a snowmobile traveling at a speed of approximately 15-20 miles per hour. Mode 3 (a moderately high engine speed) is representative of a snowmobile traveling at a speed of approximately 20-35 miles per hour, and Mode 2 (a higher engine speed) represents a snowmobile speed of 35-45 miles per hour. Mode 1 (a high engine speed) is representative of snowmobiles traveling over 45 miles per hour. Modes 4 and 2 were selected as reasonable approximations of slow and higher snowmobile travel speeds within the parks. Four different engines tested by SwRI were used to calculate average 2-stroke snowmobile emissions. For this analysis, emission factors were determined from modal testing data for the following operating conditions: Modes 5, 4, and 2. Emission factors were converted from grams per hour to grams per mile, using an equation provided to ARS by NPS. This allows determination

of speed from power. Table 4-2 summarizes the average emissions for 2-stroke snowmobile engines operating under those conditions.

4.3.2 4-Stroke Snowmobile Emission Factors

4-stroke snowmobile emission factors were calculated in a similar manner as 2-stroke engines. 4-stroke emission factors were determined from manufacturers' EPA certification modal emission testing results for the BAT-approved snowmobile engines of three different manufacturers (Arctic Cat T660, Polaris Frontier, and SkiDoo Legend with Yellowstone BAT kit). The average 4-stroke snowmobile emission factors based on these data are shown in Table 4-2.

Table 4-2
Snowmobile Emission Factors

	PM			CO			HC			NO _x		
	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)
2-Stroke snowmobiles	3.77	3.86	1.02	266	220.6	242.9	473	179.9	78.7	0.53	0.20	0.23
BAT 4- Stroke snowmobiles	0.49	0.065	0.031	191.5	35.1	22.9	35.3	2.82	2.32	0.93	2.80	5.64
Improved BAT 4- Stroke snowmobiles	0.54	0.068	0.034	137.6	18.4	10.7	35.3	0.56	0.90	1.05	0.91	3.29

Preliminary alternative 5 assumes implementation of an “improved” BAT emissions requirement. This requirement is based on the cleanest test data available; a pre-production model Polaris 4-stroke Frontier snowmobile tested in the SwRI's *Laboratory Testing of Snowmobile Emissions*, Lela and White, July 2002. The “improved” BAT emission requirements were determined from composite five-mode ISMA/SwRI cycle engine dynamometer test results of the Polaris with reference gasoline (no ethanol) for HC and CO. These proposed requirements are shown in Table 4-1, in grams per kilowatt-hour, and are based on grams per horsepower-hour test results presented in the above-referenced report. “Improved” BAT cruise emission factors for modeling purposes were calculated (from test results with units of grams per hour) and are shown in Table 4-2 (the calculations are included in Appendix B).

4.3.3 Snowcoach Emission Factors

Snowcoach emission factors for this analysis were obtained from the University of Denver's *In-use Emission Measurements of Snow Coaches and Snowmobiles in Yellowstone National Park*, Gary A. Bishop, Daniel A. Burgard, Thomas R. Dalton, and Donald H. Stedman, January 2006. This study included measuring emissions from nine (9) snowcoaches operating in Yellowstone during February of 2005. Preliminary

emissions data collected from ten (10) snowcoaches during the winter season of 2006 (*Portable Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park*, Bishop, Stadtmuller, and Stedman, report in progress) were also used, and together, this data provides the most comprehensive collection of emissions data from in-use snowcoaches to date. These studies, along with others, show that the vehicle operating conditions (altitude, temperature, terrain, vehicle operator, etc.) can greatly affect snowcoach emission factors.

A summary of the idle and traveling (low speeds of less than 15 mph and cruise speeds of 15 to 35 mph) emissions is shown in Table 4-3, representing current fleet emissions for modeling purposes. Since the snowcoaches measured in the study are not fully representative of the mix of vehicles in the overall snowcoach fleet operating in Yellowstone, emission factors were determined by weighting the data from the study based on the current fleet mix of snowcoaches operating in Yellowstone, by engine type and age (see Appendix C).

All preliminary alternatives assume implementation of a snowcoach BAT requirement based on EPA Tier 2 light-duty vehicle emission standards. Separate requirements would also need to be developed for heavy-duty/diesel snowcoaches, possibly based on EPA's Heavy-duty Diesel regulation. Future snowcoach BAT requirements are likely to only require the vehicles employ the related technologies associated with these EPA emission standards, rather than meet the actual standards themselves, as snowcoaches operate in conditions very different from their on-road counterparts.

For modeling purposes, snowcoach BAT emissions factors were determined by averaging emission factors of the cleanest subgroup of snowcoaches tested in the University of Denver studies. These emission factors represented the proposed snowcoach BAT emission values and are included in Table 4-3, and the calculations are provided in Appendix C.

4.3.4 On-road Vehicle Emission Factors

For the analysis of Preliminary Alternative 6, which includes plowing of Yellowstone's west-side roads, on-road (wheeled) vehicular emissions (CO, PM, NO_x and HC) were necessary. Emission factor estimates were computed using the EPA-developed Mobile Source Emissions Model (MOBILE6) for up to five (5) classes of motor vehicles: light-duty, gasoline-powered trucks (LDGT3 and LDGT4); heavy-duty, gasoline-powered trucks (HDGV); heavy-duty, diesel vehicles (HDDV); gasoline buses (HDGB); and diesel buses (HDDBT). The types of on-road vehicles in the fleet for this preliminary alternative would be limited since all vehicle entry would be commercially guided. The vehicle mix for this analysis was estimated to be one third of each of the following vehicle types: suburban/large passenger truck or similar; 12-15 person vans/small buses or similar light-duty trucks; and large, heavy-duty buses (30-40 feet in length).

Table 4-3
Snowcoach Emission Factors for Modeling

	PM*			CO			HC			NO _x		
	Idle (g/hr)	< 15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)
Snowcoaches – Current Fleet	0.11	0.06	0.05	441.5	164.1	254.2	24.6	5.4	10.9	3.9	15.9	15.6
Snowcoaches – 1999 Fleet	0.11	0.05	0.05	731.7	259.9	349.0	37.8	8.0	17.4	3.1	20.4	19.9
BAT Snowcoaches	0.11	0.06	0.05	43.7	17.4	38.7	12.0	1.6	1.0	4.4	8.6	11.2

Note:

* PM emissions measured only from NPS Van and NPS Bus (diesel engines).

Source: *In-use Emission Measurements of Snow Coaches and Snowmobiles in Yellowstone National Park*, University of Denver, Bishop, Burgard, Dalton, and Stedman, January 2006 and *Potable Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park*, Bishop, Stadtmuller, and Stedman, University of Denver, Report in progress.

MOBILE6 emission factors were prepared to account for high altitude, no Inspection and Maintenance (I&M) programs, conventional gasoline, and current winter inputs such as temperature (0° to 30° Fahrenheit), fuel parameters, etc. (e.g., fuel volatility). NPS provided vehicle classification data, and national default vehicle age distributions were used. Emission factors for on-road vehicles were determined for idle conditions and the same low (15mph) and cruise (35mph) speeds as modeled for oversnow vehicles, representing slower winter conditions traveling speeds.

Emission estimates typically account for three possible vehicle operating conditions: cold vehicle operation, hot start operation, and hot stabilized operation. It is important to distinguish between these three operating categories, because vehicles emit pollutants at different rates depending on whether they are cold or warmed up. Since local data are not available, MOBILE6 defaults were employed for operating conditions. Composite emission factors for modeling on-road vehicles were determined based on the vehicle mix estimated above and are shown in Table 4-4. MOBILE6 input and output files are included as Appendix D. In addition, particulate emission factors for Preliminary Alternative 6 on-road vehicle travel on paved roads (plowed) were determined using EPA's *AP-42 Section 13.2.1, Paved Roads*, December 2003. These calculations are included in Appendix H.

4.4 Traffic Activity Data

Traffic data for the air quality analysis were derived from snowmobile and snowcoach entry limits and other information for each preliminary alternative provided to ARS by NPS (Appendix A). Microscale, or localized, dispersion modeling analysis was conducted for the peak-hour periods that produce the highest levels of vehicle traffic at each of the four modeling locations, and therefore have the greatest potential for significant air quality impacts. For the emission inventory, estimated daily vehicle miles

Table 4-4
MOBILE6 Emission Factors for On-road Vehicles
(Preliminary Alternative 6 only)

	PM ₁₀			CO			HC			NO _x		
	Idle (g/hr)	< 15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)
On-Road Vehicles (Composite Mix)	0.62	0.15	0.15	188.7	30.3	19.3	14.6	1.93	1.22	28.2	7.33	5.86
Note: Vehicle mix / VMT fractions: 34% LDT4, 11% CLASS 2b HDV, 11% CLASS 3 HDV, 11% CLASS 4 HDV, 33% BUS PM ₁₀ emissions include tire and brake wear. Source: MOBILE6.2.03 September 2003.												

traveled (VMT) for oversnow and on-road vehicles (in Preliminary Alternative 6) are included in Appendix A.

To determine peak-hour vehicle traffic inputs for the West Entrance and West Entrance to Madison line source modeling locations, entrance data collected in February 2006 were used to determine morning peak-hour levels from daily entry limits. This data reflected that, on average, 65.8 percent of all daily snowmobile entries come in between 9:00 and 10:00 a.m., and 39.3 percent of all daily snowcoaches enter between 8:00 and 9:00 a.m. (37.0 percent of snowcoaches enter between 9:00 and 10:00 a.m.). Therefore, a 65.8 percent factor was applied to West Entrance daily entry limits for snowmobiles and the higher 39.3 percent factor was applied to snowcoach daily entry limits. The modeling assumed two lanes open in the morning, with about two thirds of daily entries going to the southernmost booth and third going to the middle (north) booth; the northernmost booth is currently unused in winter.

To determine peak-hour vehicle traffic inputs for the Old Faithful area source modeling location, Yellowstone Old Faithful Visitor Center staff estimated the busiest hour as approximately 11:30 a.m. to 12:30 p.m., when about 75 percent of daily visitors arrive at the Old Faithful staging area. Therefore, peak-hour traffic volumes for the staging area were estimated as 75 percent of all daily inbound traffic between Madison and Old Faithful and West Thumb and Old Faithful (inbound trips assumed to be half of total trips on each roadway segment). Peak-hour vehicle traffic inputs for the Flagg Ranch staging area were determined using a 75 percent factor, based on peak morning entry data for the South Entrance.

4.5 Meteorological Conditions

Following EPA guidelines, conservative meteorological conditions were selected for the modeling, to produce the expected highest ambient concentrations. These conservative conditions selected for CAL3QHC pollutant computations include a low wind speed of 1 meter/second and stability class F (very thermally stable). The

CAL3QHC model was utilized to vary the wind angle, to determine the wind direction which would maximize pollutant concentrations at each of the analysis locations.

Since ISC3 requires actual meteorological data input, a two month (January 1, 2000 through February 28, 2000) winter data set from the West Entrance monitoring site was used for modeling. Even though sequential meteorological data were used, the results were treated in a conservative manner because of the limited meteorological data set. The ISCST3 results were evaluated to determine the maximum predicted 1-hour average impacts (regardless of the time period(s) the impacts occurred), and maximum predicted 8-hour CO and 24-hour PM concentrations were determined using persistence factors. This approach assumes that the worst-case meteorology may occur concurrently with periods of peak emissions.

In addition, the default meteorological data used by the SCREEN3 model, which includes the full range of stability classes and windspeed combinations (Table 2. Wind Speed and Stability Classes Combinations, *SCREEN3 Model User's Guide*, USEPA, September 1995) were input to ISC3 model runs of the staging areas to determine potential impacts under meteorological conditions not measured during the monitored meteorological period. It was found that results using this data were always higher than modeling with the actual meteorological data set.

4.6 Background Concentrations

Background concentrations are those pollutant concentrations not directly accounted for by the modeling analysis. Background concentrations must be added to modeling results to obtain total pollutant concentrations at prediction sites. Background concentrations can typically be attributed to local sources, long-range transport and natural sources. For this analysis, background levels include smoke (from wood-burning stoves and fireplaces) and other emissions from West Yellowstone. Background concentrations for this analysis were estimated considering the guidelines provided in *40 CFR Part 51, Appendix W*.

Recent data collected in West Yellowstone provided background concentration estimates of a 1-hour average CO background of 0.17 ppm, and an 8-hour average CO background of 0.15 ppm, based on overnight monitoring data (John D. Ray, Atmospheric Chemist, NPS Air Resources Division, Denver, Colorado, July 2006 personal communication), so that emissions from the daytime oversnow vehicles modeled in this analysis would not be “double-counted”.

The 24-hour average PM₁₀ and PM_{2.5} background concentrations were determined from the IMPROVE network aerosol data and are 4.2 and 2.4 micrograms per cubic meter (gravimetric mass average of 2002-04 annual mean values), respectively. Consistent with EPA guidance, IMPROVE data provide representative background particulate levels that are not directly affected by winter oversnow vehicle emissions, as the monitoring station is located near Lake Village. All background concentrations used in this analysis are shown in Table 4-5.

Table 4-5
Background Concentrations

CO (ppm)	
1-hour	8-hour
0.17	0.15
24-hour Particulates (ug/m ³)	
PM ₁₀	PM _{2.5}
4.2	2.4
Note: CO backgrounds estimated from average overnight values from John D. Ray (Atmospheric Chemist, NPS Air Resources Division, Denver Colorado), July 2006, personal communication. Particulate backgrounds based on IMPROVE network aerosol data (2002-04 average).	

For the 8-hour average CO and 24-hour average PM_{2.5} concentrations, the highest 1-hour average concentrations for each pollutant were converted to either an 8-hour or 24-hour averaging period using persistence factors calculated from the *Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005*, Air Resource Specialists, August 2005. As recommended by EPA's *Guideline for Modeling Carbon Monoxide from Roadway Intersections*, November 1992, these unitless factors were determined based on the ratio of actual maximum 8-hour to 1-hour CO measurements collected at the West Entrance or Old Faithful monitoring stations for the latest three seasons of monitoring data and averaged. Persistence factors for calculating 24-hour average PM_{2.5} concentrations were also determined in this manner. Persistence factors are shown in Table 4-6

Table 4-6
Persistence Factors

	CO	PM _{2.5}
West Entrance	0.31	0.41
Old Faithful	0.43	0.15
Note: CO persistent factor for converting 1-hour concentrations to 8-hour. PM _{2.5} persistent factor for converting 1-hour concentrations to 24-hour. Persistent factors based on <i>Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005</i> , Air Resource Specialists, August 2005.		

5.0 Dispersion Modeling Results

As noted previously, receptors were placed at multiple locations at each of four modeling locations. The receptor with the highest predicted concentration was used to represent each modeling site for each of the preliminary alternatives. CO and PM concentrations were calculated for each location, for each alternative.

For all modeling results, the values shown are the highest predicted concentrations for each receptor location and include background levels. CO concentrations under each preliminary alternative were determined using the methodology previously described. Tables 5-1 and 5-2 show the maximum predicted 1- and 8-hour average CO concentrations for each of the preliminary alternatives at the analysis sites. The modeling results indicate that winter use vehicle emissions would not result in any exceedances of the CO NAAQS, or the Montana or Wyoming ambient air quality standards, under any of the preliminary alternatives. Table 5-3 shows predicted 8-hour CO levels for the alternatives as a percent of levels predicted under the 1999 Historical Conditions Scenario. Similarly, Table 5-4 shows predicted 8-hour CO as a percent of levels predicted under the Current Conditions Scenario. These percentages are based on total CO concentrations including the modeling and background values.

Table 5-5 shows the maximum predicted 24-hour PM_{2.5} concentrations for each of the preliminary alternatives at the analysis sites. The modeling results indicate that no winter use vehicle emissions from any of the preliminary alternatives would result in exceedances of the 24-hour PM_{2.5} NAAQS, or the Montana or Wyoming ambient air quality standards. The modeling results are consistent with recent (2002-2005) monitoring in the park, documented in the *Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005*, which does not show any measured CO or PM_{2.5} NAAQS exceedances. Further discussion is provided below in Section 9.0

In addition, it should be noted that all predicted PM_{2.5} concentrations for this analysis are conservative, as most available emission factors utilized for vehicles assumed total particulates, or PM₁₀ as all PM_{2.5}. In addition, 24-hour PM_{2.5} values were determined from maximum predicted 1-hour modeling results using persistence factors, which do not reflect that winter use vehicle activity occurs primarily during daytime hours, or approximately during only one third of the hours in a day (9am to 5pm). However, the modeling results indicate there would not be any exceedances of the 24-hour PM₁₀ NAAQS, or the Montana or Wyoming ambient air quality standards, under any of the preliminary alternatives.

Table 5-6 shows predicted 24-hour PM_{2.5} levels for the alternatives as a percent of levels predicted under the 1999 Historical Conditions Scenario. These percentages were determined including the appropriate background level. Similarly, Table 5-7 shows predicted 24-hour PM_{2.5} levels for the alternatives as a percent of levels predicted under the Current Conditions Scenario.

Table 5-1
Maximum Predicted 1-hour CO Concentrations
(parts per million)

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		1-hour (ppm)	1-hour (ppm)	1-hour (ppm)	1-hour (ppm)
Alternative 1a	Current Plan	6.4	1.4	0.7	4.7
Alternative 1b	Current Plan, East Entrance Closed	6.7	1.1	0.7	5.3
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	6.4	1.1	0.7	4.8
Alternative 1e	Experimental Closure Gibbon Canyon	6.4	1.1	0.8	4.7
Alternative 2	Snowcoaches Only	0.3	0.3	0.2	0.2
Alternative 3*	Eliminate Most Road Grooming	0.2	0.2	0.4	4.4
Alternative 4	Enhanced Recreational Use	7.7	1.5	0.9	6.4
Alternative 5	Provide for Unguided Access	4.3	0.6	0.5	2.9
Alternative 6	Mixed Use (West-side Roads Plowing)	2.0	0.4	0.5	4.4
Current Conditions	Current Conditions / Actual Use Scenario	3.7	0.7	0.4	1.8
1999 Historical	Historical Unregulated Scenario	23.7	21.0	1.7	8.7
Note: * Background levels only for Sites 1 and 2, since no West Entrance and Madison oversnow access for Alternative 3. NAAQS for CO are 35 and 9 parts per million (ppm), for the 1-hour and 8-hour averaging periods, respectively.					

Table 5-2
Maximum Predicted 8-hour CO Concentrations
(parts per million)

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		8-hour (ppm)	8-hour (ppm)	8-hour (ppm)	8-hour (ppm)
Alternative 1a	Current Plan	2.1	0.5	0.4	2.1
Alternative 1b	Current Plan, East Entrance Closed	2.2	0.4	0.4	2.3
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	2.1	0.4	0.4	2.1
Alternative 1e	Experimental Closure Gibbon Canyon	2.1	0.4	0.4	2.1
Alternative 2	Snowcoaches Only	0.2	0.2	0.2	0.2
Alternative 3*	Eliminate Most Road Grooming	0.2	0.2	0.2	2.0
Alternative 4	Enhanced Recreational Use	2.5	0.6	0.5	2.8
Alternative 5	Provide for Unguided Access	1.4	0.3	0.3	1.3
Alternative 6	Mixed Use (West-side Roads Plowing)	0.7	0.2	0.3	2.0
Current Conditions	Current Conditions / Actual Use Scenario	1.2	0.3	0.3	0.9
1999 Historical	Historical Unregulated Scenario	7.4**	6.6	0.8	3.8
Note: NAAQS for CO are 35 and 9 parts per million (ppm), for the 1-hour and 8-hour averaging periods, respectively. *Background levels only for Sites 1 and 2, since no West Entrance and Madison oversnow access for Alternative 3. **For actual historical unregulated conditions, Yellowstone recorded a 8-hour CO measurement of 8.9 ppm at the West Entrance air quality monitor in 1999.					

Table 5-3
Percent of Historical Conditions Concentration - 8-hour CO

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		Percent Concentration of 1999 Historical Conditions			
Alternative 1a	Current Plan	28%	8%	47%	56%
Alternative 1b	Current Plan, East Entrance Closed	29%	7%	49%	62%
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	28%	7%	47%	56%
Alternative 1e	Experimental Closure Gibbon Canyon	28%	7%	52%	56%
Alternative 2	Snowcoaches Only	2%	3%	20%	5%
Alternative 3	Eliminate Most Road Grooming	2%	2%	31%	52%
Alternative 4	Enhanced Recreational Use	33%	8%	58%	74%
Alternative 5	Provide for Unguided Access	19%	4%	36%	35%
Alternative 6	Mixed Use (West-side Roads Plowing)	10%	3%	35%	52%
Current Conditions	Current Conditions / Actual Use Scenario	17%	5%	31%	23%
1999 Historical	Historical Unregulated Scenario	100%	100%	100%	100%

Note:
Percentages determined using modeled concentrations, including background levels (0.15 parts per million for 8-hour CO).

Table 5-4
Percent of Current Conditions Concentration - 8-hour CO

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		Percent Concentration of Current Conditions			
Alternative 1a	Current Plan	168%	171%	149%	244%
Alternative 1b	Current Plan, East Entrance Closed	175%	141%	155%	270%
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	168%	141%	149%	244%
Alternative 1e	Experimental Closure Gibbon Canyon	168%	141%	165%	244%
Alternative 2	Snowcoaches Only	15%	59%	63%	21%
Alternative 3	Eliminate Most Road Grooming	12%	49%	97%	229%
Alternative 4	Enhanced Recreational Use	200%	181%	183%	325%
Alternative 5	Provide for Unguided Access	115%	90%	115%	155%
Alternative 6	Mixed Use (West-side Roads Plowing)	57%	70%	111%	228%
Current Conditions	Current Conditions / Actual Use Scenario	100%	100%	100%	100%
1999 Historical	Historical Unregulated Scenario	602%	2163%	317%	438%

Note:
Percentages determined using modeled concentrations, including background levels (0.15 parts per million for 8-hour CO).

Table 5-5
Maximum Predicted 24-hour PM_{2.5} Concentrations (micrograms per cubic meter)

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		24-hour (ug/m ³)	24-hour (ug/m ³)	24-hour (ug/m ³)	24-hour (ug/m ³)
Alternative 1a	Current Plan	9.4	2.8	2.5	3.3
Alternative 1b	Current Plan, East Entrance Closed	9.8	2.8	2.6	3.4
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	9.4	2.8	2.5	3.3
Alternative 1e	Experimental Closure Gibbon Canyon	9.4	2.8	2.6	3.3
Alternative 2	Snowcoaches Only	2.4	2.4	2.4	2.4
Alternative 3*	Eliminate Most Road Grooming	2.4	2.4	2.4	3.2
Alternative 4	Enhanced Recreational Use	10.6	3.2	2.6	3.3
Alternative 5	Provide for Unguided Access	9.8	3.2	2.5	3.2
Alternative 6	Mixed Use (West-side Roads Plowing)	21.3	26.6	7.1	3.2
Current Conditions	Current Conditions / Actual Use Scenario	6.1	2.8	2.5	2.7
1999 Historical	Historical Unregulated Scenario	193.9	42.6	4.6	10.9

Note:
 * Background levels only for Sites 1 and 2, since no West Entrance and Madison oversnow access for Alternative 3.
 NAAQS for PM₁₀ is 150 µg/m³ and for PM_{2.5} is 65 µg/m³, for the 24-hour averaging period.

Table 5-6
Percent of Historical Conditions Concentration - 24-hour PM_{2.5}

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		Percent Concentration of 1999 Historical Conditions			
Alternative 1a	Current Plan	5%	7%	55%	30%
Alternative 1b	Current Plan, East Entrance Closed	5%	7%	55%	31%
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	5%	7%	55%	30%
Alternative 1e	Experimental Closure Gibbon Canyon	5%	7%	55%	30%
Alternative 2	Snowcoaches Only	1%	6%	52%	22%
Alternative 3	Eliminate Most Road Grooming	1%	6%	52%	29%
Alternative 4	Enhanced Recreational Use	5%	8%	56%	31%
Alternative 5	Provide for Unguided Access	5%	8%	55%	29%
Alternative 6	Mixed Use (West-side Roads Plowing)	11%	62%	153%	29%
Current Conditions	Current Conditions / Actual Use Scenario	3%	7%	53%	24%
1999 Historical	Historical Unregulated Scenario	100%	100%	100%	100%

Note:
 Percentages determined using modeled concentrations, including background levels (2.4 ug/m³ parts per million for 24-hour PM_{2.5}).

Table 5-7
Percent of Current Conditions Concentration - 24-hour PM_{2.5}

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		Percent Concentration of Current Conditions			
Alternative 1a	Current Plan	154%	100%	104%	122%
Alternative 1b	Current Plan, East Entrance Closed	161%	100%	104%	126%
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	154%	100%	104%	122%
Alternative 1e	Experimental Closure Gibbon Canyon	154%	100%	105%	122%
Alternative 2	Snowcoaches Only	39%	85%	98%	91%
Alternative 3	Eliminate Most Road Grooming	39%	85%	98%	120%
Alternative 4	Enhanced Recreational Use	174%	115%	106%	125%
Alternative 5	Provide for Unguided Access	161%	115%	104%	119%
Alternative 6	Mixed Use (West-side Roads Plowing)	349%	946%	290%	119%
Current Conditions	Current Conditions / Actual Use Scenario	100%	100%	100%	100%
1999 Historical	Historical Unregulated Scenario	3183%	1515%	189%	408%
Note: Percentages determined using modeled concentrations, including background levels (2.4 ug/m ³ parts per million for 24-hour PM _{2.5}).					

Since Yellowstone and Grand Teton are Class I areas, PM₁₀ increment consumption under PSD was also assessed. For Class I areas, the PM₁₀ PSD increment is 8 micrograms per cubic meter, for the 24-hour averaging period, which EPA has determined is the small “allowable” incremental increase for PM₁₀ in these areas. This increment is evaluated in reference to the previously established (by Montana and Wyoming) baseline date of 1979 for Yellowstone (*Air Quality Concerns Related to Snowmobile Usage in National Parks*, National Park Service Air Resources Division, February 2000), which was used to determine baseline concentrations. This study employed only a screening level approach in comparing predicted PM₁₀ increments (no background contribution) with estimated 1979 baseline concentrations to determine the increment for the preliminary alternatives.

Although snowmobile (and snowcoach) traffic in the parks has increased since 1979, it was expected that the 4-stroke BAT snowmobiles required by the preliminary alternatives would generally result in a net decrease in 24-hour PM₁₀ levels compared to the established baseline date. The 1979 baseline levels were estimated from adjusting 1999 Historical Conditions Scenario modeled PM₁₀ levels based on the maximum daily snowmobile levels (from Yellowstone entry records) of the two years. As the methodology employed in this study is a screening-level analysis, it is not intended for regulatory purposes and does not constitute a regulatory PSD increment consumption analysis. Typically, detailed analysis would be required if concentrations are near or “consume” allowable Class I PM₁₀ PSD increment. Calculations for estimating baseline levels are included as Appendix G.

The predicted 24-hour PM₁₀ increment consumption values based on the previously described particulate modeling are shown in Table 5-8 for each of the preliminary alternatives. With the exception of Preliminary Alternative 6, there is no 24-hour PM₁₀ increment consumption for Sites 1, 2, and 3 compared to the baseline date, and all Site 4 results are lower than the PSD increment of 8 micrograms per cubic meter. For

Table 5-8
24-hour PM₁₀ PSD Increment Consumption

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		24-hour (ug/m ³)	24-hour (ug/m ³)	24-hour (ug/m ³)	24-hour (ug/m ³)
Alternative 1a	Current Plan	7.0	0.4	0.1	0.9
Alternative 1b	Current Plan, East Entrance Closed	7.4	0.4	0.2	1.0
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	7.0	0.4	0.1	0.9
Alternative 1e	Experimental Closure Gibbon Canyon	7.0	0.4	0.2	0.9
Alternative 2	Snowcoaches Only	0.0	0.0	0.0	0.0
Alternative 3*	Eliminate Most Road Grooming	0.0	0.0	0.0	0.8
Alternative 4	Enhanced Recreational Use	8.2	0.8	0.2	0.9
Alternative 5	Provide for Unguided Access	7.4	0.8	0.1	0.8
Alternative 6**	Mixed Use (West-side Roads Plowing)	18.9	24.2	4.7	0.8
1999 Historical***	Historical Unregulated Scenario	191.5	40.2	2.2	8.5
PSD Baseline Year	1979 Historical Conditions	42.5	8.9	0.4	0.8

Note:
 Baseline Year concentrations are based on the ratio of 1979 to 1999 snowmobile levels at the modeling locations.
 Class I PSD Increment for 24-hour average PM₁₀ is 8 µg/m³
 * No modeled increment for Sites 1 and 2, since no West Entrance and Madison oversnow access for Alternative 3.
 ** For Site 2, Class I PSD Increment is exceeded.
 *** For Sites 1 and 2, Class I PSD Increment is exceeded.

Preliminary Alternative 6, the PSD increment is exceeded for Site 2, and a more detailed modeling assessment may be required for this location. In addition, for 1999 Historical Conditions, the modeling results predict that at Sites 1 and 2, the PM₁₀ PSD increment would have been exceeded.

6.0 Emissions Inventory

In addition to the dispersion modeling analysis for determining potential short-term CO and particulate concentrations, an emissions inventory of snowmobiles and snowcoaches operating in Yellowstone, Grand Teton and the Parkway in tons per winter season was completed for each preliminary alternative, based on vehicle entry limits and other information provided (Appendix A).

Emissions were calculated using travel estimates of oversnow and on-road vehicles used on Yellowstone and Grand Teton roadways, the roadway lengths, and modes of operation of the vehicles. Emission factor data previously discussed in Section 4.3 were combined with daily vehicle traffic levels for each roadway segment, for each alternative, to determine total park-wide emissions for each pollutant. The winter season was defined as a 90-day period that typically runs from about mid-December to early March.

Estimates were prepared for criteria pollutants (CO, PM, and NO_x) and HC. The total maximum potential winter season emissions due to operations of snowmobiles and snowcoaches in the parks in tons per winter season are shown for each preliminary alternative in Table 6-1. Detailed emission inventory calculations are included as Appendix H. An emissions inventory for HAPs was also completed for each preliminary alternative and is discussed in the next section. Table 6-2 shows the contribution by vehicle type by percentage of the total season emissions for the preliminary alternatives.

The results of the emission inventory show some significant differences in tons per winter season emissions for each preliminary alternative, based on their respective entry limits and BAT requirements. Preliminary Alternative 2, with only BAT snowcoaches, results in among the lowest emissions for most pollutants, and Preliminary Alternative 3, with most road grooming eliminated, also has relatively low emissions. However, Preliminary Alternative 3 with some snowmobiles (compared to none for Preliminary Alternative 2), with emission factors generally higher than BAT snowcoaches (especially at idle), shows increased winter season emissions in comparison to Preliminary Alternative 2.

Also among lower emitting alternatives, Preliminary Alternative 5 provides for unguided snowmobile access, but also requires “improved” BAT for snowmobiles, which significantly reduces CO and HC emissions compared to current BAT snowmobiles. This compares with Preliminary Alternative 6, which has higher total snowmobile and overall emissions, despite having fewer snowmobiles (based on total entry limits) than Preliminary Alternative 5, due to requiring BAT snowmobiles instead of “improved” BAT and additional emissions from wheeled vehicles traveling on plowed roadways. Preliminary Alternative 6 is also the highest of all alternatives for particulate emissions because of the AP-42 calculated wheeled vehicle travel contribution of resuspended particulate emissions on paved roads under winter conditions.

Preliminary Alternative 4, Enhanced Recreational Use, results in the highest winter season emissions of CO, HC, and NO_x for all the preliminary alternatives, due to more higher-emitting 2-stroke snowmobiles allowed in Grand Teton, and substantially higher entry limits for Yellowstone. The various options of Preliminary Alternative 1 all result in comparable emissions, which fall between the lowest and highest emissions alternatives. However, all preliminary alternatives’ emissions are substantially lower than for the 1999 Historical Conditions scenario, which represents 2-stroke snowmobile use in the Parks at high traffic levels, under unregulated conditions. An exception that should be noted is the NO_x emissions for the 1999 Historical Conditions scenario. Despite resulting in much higher emissions of the all other pollutants assessed compared to the preliminary alternatives, the 1999 Historical Conditions scenario has the lowest NO_x emissions, due to the emissions tradeoff between 2-stroke and 4-stroke snowmobile engines that occurs for lower CO emissions.

Table 6-1
Park-wide Total Winter Season Mobile Source Emissions (Pounds per Day / Tons per Year)

Scenario	Description	CO		HC		NOx		PM	
		lb/day	tpy	lb/day	tpy	lb/day	tpy	lb/day	tpy
Alternative 1a	Current Plan	3,934	177	372	17	969	44	6	0.3
Alternative 1b	Current Plan, East Entrance Closed	3,967	179	375	17	977	44	6	0.3
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	3,788	170	357	16	933	42	6	0.3
Alternative 1e	Experimental Closure Gibbon Canyon	3,592	162	338	15	884	40	5	0.2
Alternative 2	Snowcoaches Only	827	37	22	1	239	11	1	0.0
Alternative 3	Eliminate Most Road Grooming	1,267	57	126	6	301	14	2	0.1
Alternative 4	Enhanced Recreational Use	5,939	267	640	29	1,379	62	16	0.7
Alternative 5	Provide for Unguided Access	2,115	50	153	3	616	14	6	0.1
Alternative 6	Mixed Use (West-side Roads Plowing)	2,306	104	554	25	600	27	462	20.8
Current Conditions 1999 Historical*	Current Conditions / Actual Use Scenario	2,523	114	188	8	362	16	2	0.1
	Historical Unregulated Scenario	67,662	3,045	20,109	905	203	9	277	12.5

Note:

All Alternatives and scenarios assume current snowmobile BAT, except:

- Alternative 5, which assumes Improved BAT and;
- Historical Conditions, which assumes all uncontrolled 2-stroke.

* For comparison purposes, this scenario was also modeled for the year 2010. The winter season emissions would be as follows: CO - 1,124 tpy; HC - 341 tpy; NOx - 8 tpy; PM - 12 tpy.

2010 conditions assumes standard snowmobile replacement rates based on EPA's 2006 and 2010 emissions restrictions.

For all Alternatives, Grassy Lake Road emissions from snowmobiles originating in Targhee NF assume 2007 engine mix; 20% uncontrolled 2-stroke, 70% modified & direct injection 2-stroke, and 10% 4-stroke.

Table 6-2
Percent Contribution by Vehicle Type to Total Scenario Emissions

Scenario	Description	CO			HC			NO _x			PM		
		Snowmobile	Snowcoach	On-road Vehicle	Snowmobile	Snowcoach	On-road Vehicle	Snowmobile	Snowcoach	On-road Vehicle	Snowmobile	Snowcoach	On-road Vehicle
Alternative 1a	Current Plan	86%	14%	na	96%	4%	na	84%	16%	na	88%	12%	na
Alternative 1b	Current Plan, East Entrance Closed	87%	13%	na	96%	4%	na	84%	16%	na	88%	12%	na
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	86%	14%	na	96%	4%	na	83%	17%	na	88%	12%	na
Alternative 1e	Experimental Closure Gibbon Canyon	86%	14%	na	96%	4%	na	83%	17%	na	88%	12%	na
Alternative 2	Snowcoaches Only	0%	100%	na	0%	100%	na	0%	100%	na	0%	100%	na
Alternative 3	Eliminate Most Road Grooming	89%	11%	na	97%	3%	na	87%	13%	na	92%	8%	na
Alternative 4	Enhanced Recreational Use	87%	13%	na	97%	3%	na	83%	17%	na	94%	6%	na
Alternative 5	Provide for Unguided Access	68%	32%	na	88%	12%	na	68%	32%	na	85%	15%	na
Alternative 6	Mixed Use (West-side Roads Plowing)	78%	10%	12%	96%	1%	3%	70%	15%	14%	1%	0%	99%
Current Conditions	Current Conditions / Actual Use Scenario	47%	53%	na	70%	30%	na	77%	23%	na	86%	14%	na
1999 Historical	Historical Unregulated Scenario	96%	4%	na	99%	1%	na	30%	70%	na	100%	0%	na

7.0 Hazardous Air Pollutant (HAP) Emissions

Emissions of HAPs (benzene, 1,3 butadiene, formaldehyde, and acetaldehyde) occur in snowmobile and snowcoach emissions and are associated with incomplete fuel combustion. An emission inventory for these HAPs was completed based on HC speciation estimates and the total winter season HC emissions previously determined. For snowmobiles, HAPs emissions were estimated as a fraction of measured HC emissions from 2-stroke and 4-stroke snowmobiles based on data reported in SwRI's *Laboratory Testing of Snowmobile Emissions*, Lela and White, July 2002. HAPs classified as air toxics are presented in Table 7-1 as a percentage of the total HC mass, for snowmobiles.

HAPs emissions from on-road vehicles were determined using MOBILE6. HAPs emissions from snowcoaches were calculated using the percentages of the total HC mass derived from MOBILE6, based on the on-road vehicle types that are converted to snowcoaches and the snowcoach HC emissions data from the University of Denver testing. The snowcoach vehicle mix was approximated by the following MOBILE6 vehicle mix fractions: 50 percent light-duty trucks (LDT4), 17 percent CLASS 2b heavy-duty vehicles (HDV), 17 percent CLASS 3 HDV, and 16 percent CLASS 4 HDV. A diesel fraction of five (5) percent for all vehicle classes was assumed. HAP emissions as a percentage of total HC mass, for snowcoaches and on-road vehicles are presented in Table 7-2. Using the methodology described, total winter season mobile source emissions of HAPs were estimated and are summarized in Table 7-3.

Table 7-1
Snowmobile HC Speciation Data

	2-stroke (percent of HC)	4-stroke (percent of HC)
Benzene	0.64 %	2.60 %
1-3 Butadiene	0.11 %	0.00 %
Formaldehyde	0.67 %	2.81 %
Acetaldehyde	0.47 %	1.08 %

Table 7-2
Snowcoach and On-road Vehicle HC Speciation

	Snowcoach (percent of HC)	On-road Vehicles (percent of HC)
Benzene	3.55 %	3.20 %
1-3 Butadiene	0.55 %	0.65 %
Formaldehyde	1.66 %	3.35 %
Acetaldehyde	0.49 %	1.21 %

Table 7-3
Park-wide Total Winter Season Mobile Sources HAPs Emissions
(Tons per Year)

Scenario	Description	Benzene (tpy)	1-3 Butadiene (tpy)	Formaldehyde (tpy)	Acetaldehyde (tpy)
Alternative 1a	Current Plan	0.44	0.00	0.46	0.18
Alternative 1b	Current Plan, East Entrance Closed	0.44	0.00	0.47	0.18
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	0.42	0.00	0.44	0.17
Alternative 1e	Experimental Closure Gibbon Canyon	0.40	0.00	0.42	0.16
Alternative 2	Snowcoaches Only	0.03	0.01	0.02	0.00
Alternative 3	Eliminate Most Road Grooming	0.15	0.00	0.16	0.06
Alternative 4	Enhanced Recreational Use	0.76	0.01	0.80	0.31
Alternative 5	Provide for Unguided Access	0.19	0.00	0.18	0.07
Alternative 6	Mixed Use (West-side Roads Plowing)	0.66	0.01	0.70	0.27
Current Conditions	Current Conditions / Actual Use Scenario	0.24	0.01	0.21	0.08
1999 Historical	Historical Unregulated Scenario	5.95	1.02	6.12	4.25

Note:
2-stroke and 4-stroke snowmobile HAPs estimated as a fraction of measured HC emissions based on data reported in SwRI's *Laboratory Testing of Snowmobile Emissions*, Lela and White, July 2002.
Snowcoach and on-road vehicle HAPs estimated as a fraction of HC emissions based on MOBILE6 modeling of HC and air toxics emission factors for light- and heavy-duty vehicles.

8.0 Visibility

Yellowstone and Grand Teton are classified as Class I areas under the Federal Clean Air Act. As required by the visibility protection provision of the Clean Air Act, additional procedural requirements apply when a proposed source has the potential to impair visibility in a Class I area (40 CFR 52.27 (d)). Therefore, an analysis of anticipated visibility impacts resulting from on-snow vehicle emissions was conducted following procedures in the *Workbook for Plume Visual Impact Screening and Analysis*, EPA-450/4-88-015, 1992. The EPA model VISCREEN incorporates the methodology and was used to conduct a Level 1 screening analysis of potential visibility impacts. Virtual point source methods were applied to adapt procedures originally designed for assessing plume impacts resulting from industrial stacks to the line and area sources modeled at the four locations in this study.

For the visibility analysis, a winter Yellowstone value of 240 kilometers was assumed for the background visual range. This was converted from the reference level light-extinction coefficient for Yellowstone (winter) provided in Appendix 2.B of the *Federal Land Managers' Air Quality Related Values Workgroup (FLAG), Phase I Report*, U.S Forest Service, NPS, and U.S. Fish and Wildlife Service (December 2000) using conversion equation 1 in Appendix 2.A of the report.

The results of the VISCREEN modeling are shown in Table 8-1. There were no potential localized, perceptible, visibility impairments predicted for Preliminary Alternatives 1 through 5 at the screening locations. For Preliminary Alternative 6, there would be potential localized, perceptible, visibility impairment near the West Entrance

**Table 8-1
Visibility Impairment**

Scenario	Description	Screening Criteria Exceedance			
		Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful	Site 4: Flagg Ranch
Alternative 1a	Current Plan	No	No	No	No
Alternative 1b	Current Plan, East Entrance Closed	No	No	No	No
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	No	No	No	No
Alternative 1e	Experimental Closure Gibbon Canyon	No	No	No	No
Alternative 2	Snowcoaches Only	No	No	No	No
Alternative 3	Eliminate Most Road Grooming	No	No	No	No
Alternative 4	Enhanced Recreational Use	No	No	No	No
Alternative 5	Provide for Unguided Access	No	No	No	No
Alternative 6	Mixed Use (West-side Roads Plowing)	Yes	No	Yes	No
Current Conditions	Current Conditions / Actual Use Scenario	No	No	No	No
1999 Historical	Historical Unregulated Scenario	Yes	No	No	Yes

and Old Faithful locations, due to modeled resuspended particulate emissions from wheeled vehicles. For the 1999 Historical Conditions Scenario, higher pollutant emissions from 2-stroke snowmobiles would potentially cause localized, perceptible, visibility impairment near the West Entrance and Flagg Ranch locations. Visibility modeling parameters and modeling input and output files are included as Appendix I.

9.0 Summary and Conclusions

In support of the Winter Use Plan PDEIS for Yellowstone, Grand Teton, and the Parkway, this report analyzed potential air quality impacts from snowmobile and snowcoach operations for several preliminary alternatives, utilizing air dispersion modeling and other accepted methods and models. For all preliminary alternatives, snowmobiles entering Yellowstone must be BAT machines, and in Grand Teton and the Parkway, most must be also be BAT machines. For Preliminary Alternative 5, most snowmobiles must be “improved” BAT. In addition, all preliminary alternatives assume implementation of a snowcoach BAT.

For each preliminary alternative, maximum predicted ambient concentrations of CO and PM_{2.5} were calculated using dispersion modeling and impacts were assessed with respect to the NAAQS and relative to historical conditions and a no-action scenario. Modeling results were also compared to PSD increments for particulate matter. Winter-season emission estimates in tons per year were calculated for CO, PM, NO_x, HC, and HAPs, and potential visibility impacts for each preliminary alternative were also assessed.

The results of the air quality modeling revealed that none of the alternatives would be likely to exceed the CO and PM_{2.5} NAAQS, or the Montana or Wyoming ambient air quality standards. With respect to both predicted pollutant concentrations and total winter-season emissions, compared to the 1999 Historical Conditions scenario, all of

the alternatives were projected to greatly improve CO and HC concentrations as a result of BAT requirements and daily entry limits. The largest reductions in pollutant concentrations and emissions are seen under alternatives that allow only snowcoaches, greatly limit oversnow vehicle entry, or implement “improved” BAT for snowmobiles. PM_{2.5} emissions for all the preliminary alternatives are also greatly reduced compared to the 1999 Historical Conditions scenario, with the exception of Preliminary Alternative 6, which results in higher predicted particulate emissions from the modeled wheeled vehicle travel contribution of resuspended particulate emissions under winter conditions. However, NO_x emissions are increased for all preliminary alternatives compared to the 1999 Historical Conditions scenario, due to an inverse relationship with CO emissions, a tradeoff that occurs between 2-stroke and 4-stroke snowmobile engines for lower CO emissions.

In addition, the results of the Class I PSD assessment shows that 24-hour PM₁₀ increment consumption for each of the preliminary alternatives at all modeling locations would be lower than the PSD increment of 8 micrograms per cubic meter, with the exception of Site 2 for Preliminary Alternative 6, which experiences higher predicted particulate emissions from modeled wheeled vehicle travel. The 1999 Historical Conditions scenario also exceeds the 24-hour PM₁₀ PSD increment for both Sites 1 and 2.

Modeling results from this study are compared with monitoring data collected at the West Entrance and Old Faithful sites for historical conditions (1999, with 1983 Regulations) and current conditions scenarios in tables below. Table 9-1 shows the comparison of the CO concentrations at the two locations for both historical (1999) and current conditions (2005) and Table 9-2 shows the comparison of PM_{2.5} concentrations for current conditions.

Table 9-1
Comparison of Monitored and Modeled CO Concentrations

	Year	1-hour (ppm)		8-hour (ppm)	
		Monitored	Modeled*	Monitored	Modeled*
West Entrance	1999	18.2	23.7	8.9	7.4
	2005	2.8	3.7	1.0	1.2
Old Faithful	2005	1.7	0.4	0.8	0.3
Note: * Modeled concentrations for 1999 are from 1999 Historical Conditions Scenario results, and modeled concentrations for 2005 are from Current Conditions Scenario results. Monitored 1999 concentrations from <i>Carbon Monoxide Monitoring in West Yellowstone, Montana 1998-2001</i> , John Coefield, Montana DEQ, May 2002. Monitored 2005 concentrations from <i>Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005</i> , Air Resource Specialists, August 2005.					

Table 9-2
Comparison of Monitored and Modeled PM_{2.5} Concentrations

		24-hour (ug/m³)	
	Year	Monitored	Modeled*
West Entrance	2005	9.5	6.1
Old Faithful	2005	6.0	2.5
Note: *Modeled concentrations are from Current Conditions Scenario results. Monitored concentrations from <i>Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005</i> , Air Resource Specialists, August 2005.			

The comparison of monitored versus modeled concentrations for CO at the West Entrance are generally consistent with the typical conservative predictions of dispersion modeling. Modeled concentrations for CO at Old Faithful and PM_{2.5} concentrations at both locations are lower than monitored values. However, given the modeling approach must employ a series of assumptions and approximations of actual conditions, utilizing the best available emission factors, and other input parameters, etc., compared with monitored concentrations, the modeling results are within a reasonable in range of possibility, and assess the potential for impacts to air quality from the winter use preliminary alternatives. The modeling results presented in this report provide an assessment of the effects on air quality associated with the entry limits, BAT requirements, and other details of the preliminary alternatives under consideration in the PDEIS.

DRAFT
AIR QUALITY MODELING REPORT
SNOWMOBILE AND SNOWCOACH EMISSIONS

APPENDICES

**YELLOWSTONE and GRAND TETON NATIONAL PARKS and the
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APPENDIX A
MOTORIZED OVERSNOW VEHICLE SCENARIOS

Appendix A: Motorized Oversnow Vehicle Scenarios

Introduction

The development of a model to distribute use within the parks, based on entrance limits, is necessary in order to understand the impacts of the alternatives on park resources and values. These models, called scenarios, were developed for the ongoing winter use plans/EIS, as well as in the past for the Temporary Winter Use EA, the SEIS, and the EIS. Each scenario attempts to predict the total amount of daily recreational traffic on specific road segments within Yellowstone and Grand Teton National Parks, by vehicle type. Thus, by looking at the scenarios, one can get a sense of how much snowmobile or snowcoach traffic to expect in a day on each road segment within the parks.

The purpose of the distribution model is similar to other models developed for the EIS, such the air quality and natural soundscape models. The scenarios are also fundamental to the air quality and soundscapes analysis, as they are inputs to these models. Each of these models does their best to reasonably replicate reality, but that is not their fundamental purpose. The purpose of the models is to provide a comparison of the relative differences among the alternatives. This helps the decision-maker better understand the magnitude of differences of the environmental consequences of each alternative.

For the development of this new long-term EIS, the scenarios were updated for two major reasons. First, park managers and partners recognize that commercially guided trips may have different visitation patterns than unguided groups. For example, many snowmobile touring businesses currently offer two main destinations for their tours: Old Faithful or Canyon. By contrast, unguided visitors have less predictable visitation patterns. The previous scenarios were developed with data largely from unguided snowmobilers. Most of the alternatives considered in this document require some portion of snowmobile entries to be commercially guided. Thus, there could be differences in the travel and visitation patterns for guided vs. unguided (or non-commercially guided) groups.

Second, the previous scenarios only included in-bound traffic within Yellowstone National Park. They did not include traffic exiting the park.¹ For example, if a group of snowmobiles entered Yellowstone at the West Entrance, and traveled to Old Faithful, they would be “counted” by the previous scenarios on their in-bound trip to Old Faithful. After enjoying the geyser basin, if the group returned to the West Entrance to complete their visit for the day, they would not have been “counted” by the previous model as

¹ To illustrate this, note the scenario from the preferred alternative of the EA, on page A-8 of the EA. This scenario shows 428 snowmobiles traveling the West Entrance to Madison road segment, with a daily entry limit for the West Entrance of 400. The scenario (and all others) assumes that the daily entry limit of 400 snowmobiles is reached. A handful of snowmobiles that enter at other entrances, for example the North Entrance, will also traverse the West Entrance to Madison road segment (perhaps to see wildlife along this corridor or visit West Yellowstone), which accounts for the extra 28 snowmobiles beyond 400. However, the majority of those 400 snowmobiles entering through the West Entrance return on this road segment when they leave the park at the end of their tour in Yellowstone. A few will stay overnight in the park or in another gateway community, but the majority return to their origin at the end of the day. Thus, to account for exit traffic, the figure should be substantially higher than 428 snowmobiles.

traveling on those road segments a second time. This presents a problem, as it potentially excludes a substantial amount of traffic. This factor alone warranted a re-examination of the assumptions.

Methods Used to Develop the New Scenarios

The primary issue in creating new scenarios for this EIS process is developing factors to distribute traffic along each road segment. For example, of the snowmobiles entering in a single day at the West Entrance, what percent travel to Old Faithful, what percent travel to Canyon, what percent complete the Grand Loop, and what percent go to other destinations in their day of travel in Yellowstone?

To answer these questions, the Yellowstone planning staff considered several sources of information. First, the distribution factors in the EA, SEIS, and EIS were reviewed. In addition, several previous winter visitor surveys were reviewed. Two surveys in particular asked visitors where they went on their trip in Yellowstone, and whether or not they were part of a commercially guided tour.² The authors of these surveys were contacted and asked to prepare cross tabulations of where visitors traveling with commercial guides actually went on their visit to the parks. This data illustrated where visitors stated they went on their tour of Yellowstone. Finally, planning staff discussed with several commercial guiding businesses (both snowmobile and snowcoach) where their tours actually go in the park. In addition, Xanterra Parks and Resorts, Yellowstone's largest concessioner, provided data on where the destinations of their Old Faithful-based snowmobile and snowcoach tours. This provided real-world confirmation of the survey data and the previous scenario's distribution factors.

After these sources of information were considered, distribution factors were developed. Assumptions were made (based on the above information) about the destinations for the commercially guided tours. For example, an assumption was made that approximately 75% of tours entering the park at the West Entrance have Old Faithful as their primary destination, while 20% have the Grand Canyon of the Yellowstone as their destination. Roughly 5% of visitors have other destinations – perhaps traveling the Grand Loop in a day, or to another entrance. In addition, assumptions were made about other road segments that might be used by groups given those destinations. Continuing the previous example, an assumption was made about the percent of visitors that might have Old Faithful as their primary destination, but also travel up to view Gibbon Falls on the Madison to Norris road segment (not along the normal route between the West Entrance and Old Faithful). Similar projections about use on each road segment were made for each of the oversnow entrances. However, in order to be counted on a road segment, traffic need to travel more than 2-3 miles. For example, if a group of snowmobilers visit Kepler Cascades, located approximately 2 miles from Old Faithful, viewed the Cascades and returned to Old Faithful, they would not have been counted as having used the Old Faithful-West Thumb road segment, as they only traveled such a small portion of it.

² The surveys used were: 1) Mansfield, C., F.R. Johnson, R. Whitmore, and D. Phaneuf, October 2003. Winter 2002-2003 Visitor Survey: Yellowstone and Grand Teton National Parks. Prepared by RTI International et al under contract to the National Park Service. 2) Littlejohn, M. February 1996. Visitor Services Project: Yellowstone National Park Visitor Survey, Report 75. University of Idaho, Moscow, ID.

In addition, an assumption was made in the analysis that the use limits prescribed by each alternative are reached each day of the peak season (January and February). This assumption was used in the previous scenarios, and is carried over here. This is a critical assumption because it allows the decision-maker to understand the impacts of the alternatives at their full implementation level.

At first, only the in-bound traffic was considered, since this was most consistent with the previous scenarios. The updated scenario distribution models were run for Alternative A – Continue the Temporary Plan, and the results were extremely comparable to the previous scenarios. This provided an initial validity check of the new scenarios.

Next, the distribution factors were updated to include the out-bound traffic. Again, assumptions were made about what percent of visitors from each entrance overnight at Snow Lodge, complete the Grand Loop, or exit at another entrance (generally a relatively small percent do these activities).

General Assumptions, by entrance:

At the forefront, it is critical to note that the assumptions below are intended to only roughly reflect visitation patterns. It is not necessary to have these assumptions precisely reflect actual visitation patterns. What is critical is that the same assumptions are used for each alternative's scenarios, which allows comparisons to be made among the alternatives.

West Entrance:

- 75% have Old Faithful as primary destination
- 20% have Canyon as primary destination
- 6% complete the Grand Loop
- 12% overnight at North, South, or East
- 8% overnight at Snow Lodge

South Entrance:

- 75% have Old Faithful as primary destination
- 20% have Canyon as primary destination
- 5% complete the Grand Loop
- 13% overnight at North, West, or East
- 12% overnight at Snow Lodge

East Entrance:

- 20% have Old Faithful as primary destination
- 75% have Canyon as primary destination
- 0% complete the Grand Loop
- 30% overnight at North, South, or West
- 10% overnight at Snow Lodge

North Entrance:

- 70% have Old Faithful as primary destination
- 30% have Canyon as primary destination
- 2% complete the Grand Loop
- 9% overnight at West, South, or East
- 11% overnight at Snow Lodge

Old Faithful:

- 70% of snowmobiles complete the Grand Loop
- 6% of snowcoaches complete the Grand Loop

The distribution factors were entered into a Microsoft Excel spreadsheet to produce the scenario results.

Results

The oversnow vehicle distribution scenarios follow for each alternative. They are broken out by vehicle type – snowmobile or snowcoach (and wheeled vehicle in the case of alternative I). The entrance limits are multiplied by the road segment factor to generate the number of vehicles utilizing that road segment. For example, in Alternative A, 5% of snowmobiles entering the park's West Entrance are presumed to travel along the Mammoth to Norris road segment. Given a limit of 400 snowmobiles per day at the West Entrance, this equates to 20 snowmobiles along this road segment from the West Entrance ($.05 \times 400 = 20$).

Alternative 1a - Continue Temporary Winter Plan with East Entrance Open to OSV travel

Snowmobiles	West Entrance 400		South Entrance 220		East Entrance 40		North Entrance 30		Old Faithful 30		Totals 720
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	20	0.03	6.6	0.1	4	1.8	54	0.3	9	93.6
West Entrance to Madison	1.8	720	0.05	11	0.1	4	0.15	4.5	0.15	4.5	744
Madison to Norris	0.59	236	0.08	17.6	0.1	4	1.2	36	1	30	323.6
Norris to Canyon Village	0.44	176	0.05	11	0.2	8	0.56	16.8	0.7	21	232.8
Canyon Village to Fishing Bridge	0.34	136	0.45	99	1.4	56	0.36	10.8	0.7	21	322.8
Fishing Bridge to East Entrance	0.02	8	0.05	11	1.6	64	0.02	0.6	0.02	0.6	84.2
Fishing Bridge to West Thumb	0.08	32	0.46	101.2	0.3	12	0.02	0.6	0.7	21	166.8
Madison to Old Faithful	1.41	564	0.47	103.4	0.1	4	1.15	34.5	1.05	31.5	737.4
Old Faithful to West Thumb	0.27	108	1.35	297	0.2	8	0.05	1.5	0.75	22.5	437
West Thumb to Flagg Ranch	0.05	20	1.75	385	0.1	4	0.05	1.5	0.05	1.5	412

Snowcoaches	West Entrance 34		South Entrance 10		East Entrance 3		North Entrance 13		Old Faithful 18		Totals 78
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	1.7	0.03	0.3	0.1	0.3	1.8	23.4	0	0	25.7
West Entrance to Madison	1.8	61.2	0.05	0.5	0.1	0.3	0.15	1.95	0.48	8.64	72.59
Madison to Norris	0.59	20.06	0.08	0.8	0.1	0.3	1.2	15.6	0.06	1.08	37.84
Norris to Canyon Village	0.44	14.96	0.05	0.5	0.2	0.6	0.56	7.28	0.06	1.08	24.42
Canyon Village to Fishing Bridge	0.34	11.56	0.45	4.5	1.4	4.2	0.36	4.68	0.06	1.08	26.02
Fishing Bridge to East Entrance	0.02	0.68	0.05	0.5	1.6	4.8	0.02	0.26	0	0	6.24
Fishing Bridge to West Thumb	0.08	2.72	0.46	4.6	0.3	0.9	0.02	0.26	0.06	1.08	9.56
Madison to Old Faithful	1.41	47.94	0.47	4.7	0.1	0.3	1.15	14.95	0.6	10.8	78.69
Old Faithful to West Thumb	0.27	9.18	1.35	13.5	0.2	0.6	0.05	0.65	1.3	23.4	47.33
West Thumb to Flagg Ranch	0.05	1.7	1.75	17.5	0.1	0.3	0.05	0.65	1.18	21.24	41.39

Snowmobiles	CDST 50		Grassy Lake Rd 50		Jackson Lake 40		Totals 140
GRTE Road Segment	Factor	Results	Factor	Results	Factor	Results	
Moran Junction to Flagg Ranch	2	100	0	0	0	0	100
Flagg Ranch west to boundary	0	0	1.9	95	0	0	95
Jackson Lake fishing access	0	0	0	0	2	80	80

Note:

YELL group sizes are modeled at 90% 8 snowmobiles/group and 10% at 17 snowmobiles/group.

GRTE group sizes are modeled at 5, except Jackson Lake which is modeled as a single user.

Alternative 1b - Continue Temporary Winter Plan with East Entrance closed

Snowmobiles	West Entrance 424		South Entrance 256		East Entrance 0		North Entrance 20		Old Faithful 20		Totals 720
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	21.2	0.03	7.68	0.1	0	1.8	36	0.3	6	70.88
West Entrance to Madison	1.8	763.2	0.05	12.8	0.1	0	0.15	3	0.15	3	782
Madison to Norris	0.59	250.16	0.08	20.48	0.1	0	1.2	24	1	20	314.64
Norris to Canyon Village	0.44	186.56	0.05	12.8	0.2	0	0.56	11.2	0.7	14	224.56
Canyon Village to Fishing Bridge	0.34	144.16	0.45	115.2	1.4	0	0.36	7.2	0.7	14	280.56
Fishing Bridge to Lake Butte	0.02	8.48	0.05	12.8	1.6	0	0.02	0.4	0.02	0.4	22.08
Fishing Bridge to West Thumb	0.08	33.92	0.46	117.76	0.3	0	0.02	0.4	0.7	14	166.08
Madison to Old Faithful	1.41	597.84	0.47	120.32	0.1	0	1.15	23	1.05	21	762.16
Old Faithful to West Thumb	0.27	114.48	1.35	345.6	0.2	0	0.05	1	0.75	15	476.08
West Thumb to Flagg Ranch	0.05	21.2	1.85	473.6	0.1	0	0.05	1	0.05	1	496.8

Snowcoaches	West Entrance 34		South Entrance 13		East Entrance 0		North Entrance 13		Old Faithful 18		Totals 78
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	1.7	0.03	0.39	0.1	0	1.8	23.4	0	0	25.49
West Entrance to Madison	1.8	61.2	0.05	0.65	0.1	0	0.15	1.95	0.48	8.64	72.44
Madison to Norris	0.59	20.06	0.08	1.04	0.1	0	1.2	15.6	0.06	1.08	37.78
Norris to Canyon Village	0.44	14.96	0.05	0.65	0.2	0	0.56	7.28	0.06	1.08	23.97
Canyon Village to Fishing Bridge	0.34	11.56	0.45	5.85	1.4	0	0.36	4.68	0.06	1.08	23.17
Fishing Bridge to Lake Butte	0.02	0.68	0.05	0.65	1.6	0	0.02	0.26	0	0	1.59
Fishing Bridge to West Thumb	0.08	2.72	0.46	5.98	0.3	0	0.02	0.26	0.06	1.08	10.04
Madison to Old Faithful	1.41	47.94	0.47	6.11	0.1	0	1.15	14.95	0.6	10.8	79.8
Old Faithful to West Thumb	0.27	9.18	1.35	17.55	0.2	0	0.05	0.65	1.3	23.4	50.78
West Thumb to Flagg Ranch	0.05	1.7	1.75	22.75	0.1	0	0.05	0.65	1.18	21.24	46.34

Snowmobiles	CDST 50		Grassy Lake Rd 50		Jackson Lake 40		Totals 140
GRTE Road Segment	Factor	Results	Factor	Results	Factor	Results	
Moran Junction to Flagg Ranch	2	100	0	0	0	0	100
Flagg Ranch west to boundary	0	0	1.9	95	0	0	95
Jackson Lake fishing access	0	0	0	0	2	80	80

Note:

For the South Entrance road segment, the travel factor from West Thumb to Flagg Ranch is increased by 0.1 to account for traffic previously modeled as traveling through the East Entrance.

YELL group sizes are modeled at 11 snowmobiles/group

GRTE group sizes are modeled at 5, except Jackson Lake which is modeled as a single user

Alternative 1d - Continue Temporary Winter Plan with East Entrance closed - eliminate 40 entries

Snowmobiles	West Entrance 400		South Entrance 220		East Entrance 0		North Entrance 30		Old Faithful 30		Totals 680
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	20	0.03	6.6	0.1	0	1.8	54	0.3	9	89.6
West Entrance to Madison	1.8	720	0.05	11	0.1	0	0.15	4.5	0.15	4.5	740
Madison to Norris	0.59	236	0.08	17.6	0.1	0	1.2	36	1	30	319.6
Norris to Canyon Village	0.44	176	0.05	11	0.2	0	0.56	16.8	0.7	21	224.8
Canyon Village to Fishing Bridge	0.34	136	0.45	99	1.4	0	0.36	10.8	0.7	21	266.8
Fishing Bridge to Lake Butte	0.02	8	0.05	11	1.6	0	0.02	0.6	0.02	0.6	20.2
Fishing Bridge to West Thumb	0.08	32	0.46	101.2	0.3	0	0.02	0.6	0.7	21	154.8
Madison to Old Faithful	1.41	564	0.47	103.4	0.1	0	1.15	34.5	1.05	31.5	733.4
Old Faithful to West Thumb	0.27	108	1.35	297	0.2	0	0.05	1.5	0.75	22.5	429
West Thumb to Flagg Ranch	0.05	20	1.85	407	0.1	0	0.05	1.5	0.05	1.5	430

Snowcoaches	West Entrance 34		South Entrance 13		East Entrance 0		North Entrance 13		Old Faithful 18		Totals 78
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	1.7	0.03	0.39	0.1	0	1.8	23.4	0	0	25.49
West Entrance to Madison	1.8	61.2	0.05	0.65	0.1	0	0.15	1.95	0.48	8.64	72.44
Madison to Norris	0.59	20.06	0.08	1.04	0.1	0	1.2	15.6	0.06	1.08	37.78
Norris to Canyon Village	0.44	14.96	0.05	0.65	0.2	0	0.56	7.28	0.06	1.08	23.97
Canyon Village to Fishing Bridge	0.34	11.56	0.45	5.85	1.4	0	0.36	4.68	0.06	1.08	23.17
Fishing Bridge to Lake Butte	0.02	0.68	0.05	0.65	1.6	0	0.02	0.26	0	0	1.59
Fishing Bridge to West Thumb	0.08	2.72	0.46	5.98	0.3	0	0.02	0.26	0.06	1.08	10.04
Madison to Old Faithful	1.41	47.94	0.47	6.11	0.1	0	1.15	14.95	0.6	10.8	79.8
Old Faithful to West Thumb	0.27	9.18	1.35	17.55	0.2	0	0.05	0.65	1.3	23.4	50.78
West Thumb to Flagg Ranch	0.05	1.7	1.75	22.75	0.1	0	0.05	0.65	1.18	21.24	46.34

Snowmobiles	CDST 50		Grassy Lake Rd 50		Jackson Lake 40		Totals 140
GRTE Road Segment	Factor	Results	Factor	Results	Factor	Results	
Moran Junction to Flagg Ranch	2	100	0	0	0	0	100
Flagg Ranch west to boundary	0	0	1.9	95	0	0	95
Jackson Lake fishing access	0	0	0	0	2	80	80

Note:

For the South Entrance road segment, the travel factor from West Thumb to Flagg Ranch is increased by 0.1 to account for traffic previously modeled as traveling through the East Entrance.

Alternative 1c will not be modeled because the numbers and operational considerations are adequately modeled by Alternatives 1d and 1e.

YELL group sizes are modeled at 11 snowmobiles/group

GRTE group sizes are modeled at 5, except Jackson Lake which is modeled as a single user

Alternative 1e - Experimental road closure in Gibbon Canyon

Snowmobiles	West Entrance 400		South Entrance 220		East Entrance 0		North Entrance 30		Old Faithful 30		Totals 680
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	20	0.03	6.6	0.1	0	1.85	55.5	0.15	4.5	86.6
West Entrance to Madison	1.8	720	0.1	22	0.1	0	0.02	0.6	0.3	9	751.6
Madison to Norris	0	0	0	0	0	0	0	0	0	0	0
Norris to Canyon Village	0.05	20	0.03	6.6	0.2	0	1.25	37.5	0.15	4.5	68.6
Canyon Village to Fishing Bridge	0.05	20	0.37	81.4	1.4	0	0.85	25.5	1.25	37.5	164.4
Fishing Bridge to Lake Butte	0.02	8	0.05	11	1.6	0	0.02	0.6	0.02	0.6	20.2
Fishing Bridge to West Thumb	0.15	60	0.43	94.6	0.3	0	0.15	4.5	1.25	37.5	196.6
Madison to Old Faithful	1.8	720	0.5	110	0.1	0	0.02	0.6	0.4	12	842.6
Old Faithful to West Thumb	0.45	180	1.38	303.6	0.2	0	0.13	3.9	1.3	39	526.5
West Thumb to Flagg Ranch	0.1	40	1.75	385	0.1	0	0.02	0.6	0.05	1.5	427.1

Snowcoaches	West Entrance 34		South Entrance 13		East Entrance 0		North Entrance 13		Old Faithful 18		Totals 78
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	1.7	0.03	0.39	0.1	0	1.85	24.05	0.15	2.7	28.84
West Entrance to Madison	1.8	61.2	0.1	1.3	0.1	0	0.02	0.26	0.3	5.4	68.16
Madison to Norris	0	0	0	0	0	0	0	0	0	0	0
Norris to Canyon Village	0.05	1.7	0.03	0.39	0.2	0	1.25	16.25	0.15	2.7	21.04
Canyon Village to Fishing Bridge	0.05	1.7	0.37	4.81	1.4	0	0.85	11.05	1.25	22.5	40.06
Fishing Bridge to Lake Butte	0.02	0.68	0.05	0.65	1.6	0	0.02	0.26	0	0	1.59
Fishing Bridge to West Thumb	0.15	5.1	0.43	5.59	0.3	0	0.15	1.95	1.25	22.5	35.14
Madison to Old Faithful	1.8	61.2	0.5	6.5	0.1	0	0.02	0.26	0.4	7.2	75.16
Old Faithful to West Thumb	0.45	15.3	1.38	17.94	0.2	0	0.13	1.69	1.3	23.4	58.33
West Thumb to Flagg Ranch	0.1	3.4	1.75	22.75	0.1	0	0.02	0.26	0.05	0.9	27.31

Snowmobiles	CDST 50		Grassy Lake Rd 50		Jackson Lake 40		Totals 140
GRTE Road Segment	Factor	Results	Factor	Results	Factor	Results	
Moran Junction to Flagg Ranch	2	100	0	0	0	0	100
Flagg Ranch west to boundary	0	0	1.9	95	0	0	95
Jackson Lake fishing access	0	0	0	0	2	80	80

Note:

YELL group sizes are modeled at 11 snowmobiles/group

GRTE group sizes are modeled at 5, except Jackson Lake which is modeled as a single user

Alternative 2 - Snowcoach only

Snowmobiles	West Entrance 0		South Entrance 0		East Entrance 0		North Entrance 0		Old Faithful 0		Total 0
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	0	0.03	0	0.1	0	1.8	0	0.3	0	0
West Entrance to Madison	1.8	0	0.05	0	0.1	0	0.15	0	0.15	0	0
Madison to Norris	0.59	0	0.08	0	0.1	0	1.2	0	1	0	0
Norris to Canyon Village	0.44	0	0.05	0	0.2	0	0.56	0	0.7	0	0
Canyon Village to Fishing Bridge	0.34	0	0.45	0	1.4	0	0.36	0	0.7	0	0
Fishing Bridge to Lake Butte	0.02	0	0.05	0	1.6	0	0.02	0	0.02	0	0
Fishing Bridge to West Thumb	0.08	0	0.46	0	0.3	0	0.02	0	0.7	0	0
Madison to Old Faithful	1.41	0	0.47	0	0.1	0	1.15	0	1.05	0	0
Old Faithful to West Thumb	0.27	0	1.35	0	0.2	0	0.05	0	0.75	0	0
West Thumb to Flagg Ranch	0.05	0	1.75	0	0.1	0	0.05	0	0.05	0	0

Snowcoaches	West Entrance 55		South Entrance 25		East Entrance 0		North Entrance 17		Old Faithful 23		Total 120
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	2.75	0.03	0.75	0.1	0	1.8	30.6	0	0	34.1
West Entrance to Madison	1.8	99	0.05	1.25	0.1	0	0.15	2.55	0.48	11.04	113.84
Madison to Norris	0.59	32.45	0.08	2	0.1	0	1.2	20.4	0.06	1.38	56.23
Norris to Canyon Village	0.44	24.2	0.05	1.25	0.2	0	0.56	9.52	0.06	1.38	36.35
Canyon Village to Fishing Bridge	0.34	18.7	0.45	11.25	1.4	0	0.36	6.12	0.06	1.38	37.45
Fishing Bridge to Lake Butte	0.02	1.1	0.05	1.25	1.6	0	0.02	0.34	0	0	2.69
Fishing Bridge to West Thumb	0.08	4.4	0.46	11.5	0.3	0	0.02	0.34	0.06	1.38	17.62
Madison to Old Faithful	1.41	77.55	0.47	11.75	0.1	0	1.15	19.55	0.6	13.8	122.65
Old Faithful to West Thumb	0.27	14.85	1.35	33.75	0.2	0	0.05	0.85	1.3	29.9	79.35
West Thumb to Flagg Ranch	0.05	2.75	1.75	43.75	0.1	0	0.05	0.85	1.18	27.14	74.49

Snowmobiles	CDST 0		Grassy Lake Rd 0		Jackson Lake 0		Totals 0
GRTE Road Segment	Factor	Results	Factor	Results	Factor	Results	
Moran Junction to Flagg Ranch							
Flagg Ranch west to boundary							
Jackson Lake fishing access							

Note:

For the South Entrance road segment, the travel factor from West Thumb to Flagg Ranch is increased by 0.1 to account for traffic previously modeled as traveling through the East Entrance.

Alternative 3 - Eliminate most road grooming

Snowmobiles	West Entrance		South Entrance		East Entrance		North Entrance		Old Faithful		Total
	0		250		0		0		0		250
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	0	0	0	0.1	0	1.8	0	0.3	0	0
West Entrance to Madison	1.8	0	0	0	0.1	0	0.15	0	0.15	0	0
Madison to Norris	0.59	0	0	0	0.1	0	1.2	0	1	0	0
Norris to Canyon Village	0.44	0	0	0	0.2	0	0.56	0	0.7	0	0
Canyon Village to Fishing Bridge	0.34	0	0	0	1.4	0	0.36	0	0.7	0	0
Fishing Bridge to Lake Butte	0.02	0	0	0	1.6	0	0.02	0	0.02	0	0
Fishing Bridge to West Thumb	0.08	0	0	0	0.3	0	0.02	0	0.7	0	0
Madison to Old Faithful	1.41	0	0	0	0.1	0	1.15	0	1.05	0	0
Old Faithful to West Thumb	0.27	0	2	500	0.2	0	0.05	0	0.75	0	500
West Thumb to Flagg Ranch	0.05	0	2	500	0.1	0	0.05	0	0.05	0	500

Snowcoaches	West Entrance		South Entrance		East Entrance		North Entrance		Old Faithful		Total
	0		20		0		0		0		20
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	0	0	0	0.1	0	1.8	0	0	0	0
West Entrance to Madison	1.8	0	0	0	0.1	0	0.15	0	0.48	0	0
Madison to Norris	0.59	0	0	0	0.1	0	1.2	0	0.06	0	0
Norris to Canyon Village	0.44	0	0	0	0.2	0	0.56	0	0.06	0	0
Canyon Village to Fishing Bridge	0.34	0	0	0	1.4	0	0.36	0	0.06	0	0
Fishing Bridge to Lake Butte	0.02	0	0	0	1.6	0	0.02	0	0	0	0
Fishing Bridge to West Thumb	0.08	0	0	0	0.3	0	0.02	0	0.06	0	0
Madison to Old Faithful	1.41	0	0	0	0.1	0	1.15	0	0.6	0	0
Old Faithful to West Thumb	0.27	0	2	40	0.2	0	0.05	0	1.3	0	40
West Thumb to Flagg Ranch	0.05	0	2	40	0.1	0	0.05	0	1.18	0	40

Snowmobiles	CDST		Grassy Lake Rd		Jackson Lake		Total
	0		50		0		50
GRTE Road Segment	Factor	Results	Factor	Results	Factor	Results	
Moran Junction to Flagg Ranch	0	0	0	0	0	0	0
Flagg Ranch west to boundary	0	0	2	100	0	0	100
Jackson Lake fishing access	0	0	0	0	0	0	0

Note:

YELL group sizes are modeled at 11 snowmobiles/group

GRTE group sizes are modeled at 5, except Jackson Lake which is modeled as a single user

Alternative 4 - Expand Recreational Use

Snowmobiles	West Entrance 600		South Entrance 250		East Entrance 100		North Entrance 25		Old Faithful 50		Total 1025
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	30	0.03	7.5	0.1	10	1.8	45	0.3	15	107.5
West Entrance to Madison	1.8	1080	0.05	12.5	0.1	10	0.15	3.75	0.15	7.5	1113.75
Madison to Norris	0.59	354	0.08	20	0.1	10	1.2	30	1	50	464
Norris to Canyon Village	0.44	264	0.05	12.5	0.2	20	0.56	14	0.7	35	345.5
Canyon Village to Fishing Bridge	0.34	204	0.45	112.5	1.4	140	0.36	9	0.7	35	500.5
Fishing Bridge to East Entrance	0.02	12	0.05	12.5	1.6	160	0.02	0.5	0.02	1	186
Fishing Bridge to West Thumb	0.08	48	0.46	115	0.3	30	0.02	0.5	0.7	35	228.5
Madison to Old Faithful	1.41	846	0.47	117.5	0.1	10	1.15	28.75	1.05	52.5	1054.75
Old Faithful to West Thumb	0.27	162	1.35	337.5	0.2	20	0.05	1.25	0.75	37.5	558.25
West Thumb to Flagg Ranch	0.05	30	1.75	437.5	0.1	10	0.05	1.25	0.05	2.5	481.25

Snowcoaches	West Entrance 50		South Entrance 19		East Entrance 5		North Entrance 17		Old Faithful 24		Total 115
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	2.5	0.03	0.57	0.1	0.5	1.8	30.6	0	0	34.17
West Entrance to Madison	1.8	90	0.05	0.95	0.1	0.5	0.15	2.55	0.48	11.52	105.52
Madison to Norris	0.59	29.5	0.08	1.52	0.1	0.5	1.2	20.4	0.06	1.44	53.36
Norris to Canyon Village	0.44	22	0.05	0.95	0.2	1	0.56	9.52	0.06	1.44	34.91
Canyon Village to Fishing Bridge	0.34	17	0.45	8.55	1.4	7	0.36	6.12	0.06	1.44	40.11
Fishing Bridge to East Entrance	0.02	1	0.05	0.95	1.6	8	0.02	0.34	0	0	10.29
Fishing Bridge to West Thumb	0.08	4	0.46	8.74	0.3	1.5	0.02	0.34	0.06	1.44	16.02
Madison to Old Faithful	1.41	70.5	0.47	8.93	0.1	0.5	1.15	19.55	0.6	14.4	113.88
Old Faithful to West Thumb	0.27	13.5	1.35	25.65	0.2	1	0.05	0.85	1.3	31.2	72.2
West Thumb to Flagg Ranch	0.05	2.5	1.75	33.25	0.1	0.5	0.05	0.85	1.18	28.32	65.42

Snowmobiles	CDST 75		Grassy Lake Rd 75		Jackson Lake 100		Totals 250
GRTE Road Segment	Factor	Results	Factor	Results	Factor	Results	
Moran Junction to Flagg Ranch	2	150	0	0	0	0	150
Flagg Ranch west to boundary	0	0	1.9	142.5	0	0	142.5
Jackson Lake fishing access	0	0	0	0	2	200	200

Note:

This alternative includes 10 private snowcoaches which are modeled at the following entrances:

West Entrance	4
South Entrance	4
East Entrance	1
North Entrance	1

For YELL 25% of snowmobile entries modeled for this alternative are either unguided or non-commercially guided.

For GRTE 50 of the 75 snowmobile entries are modeled as guided. This differs from all other GRTE alternatives, where use is 100% unguided.

YELL group sizes are modeled at 11 snowmobiles/guided group

YELL group sizes are modeled at 5 snowmobiles/unguided group

GRTE group sizes are modeled at 5, except Jackson Lake which is modeled as a single user

Alternative 5 - Unguided Access

Snowmobiles	West Entrance 336		South Entrance 168		East Entrance 46		North Entrance 46		Old Faithful 29		Total 625
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	16.8	0.03	5.04	0.1	4.6	1.8	82.8	0.3	8.7	117.94
West Entrance to Madison	1.8	604.8	0.05	8.4	0.1	4.6	0.15	6.9	0.15	4.35	629.05
Madison to Norris	0.59	198.24	0.08	13.44	0.1	4.6	1.2	55.2	1	29	300.48
Norris to Canyon Village	0.44	147.84	0.05	8.4	0.2	9.2	0.56	25.76	0.7	20.3	211.5
Canyon Village to Fishing Bridge	0.34	114.24	0.45	75.6	1.4	64.4	0.36	16.56	0.7	20.3	291.1
Fishing Bridge to East Entrance	0.02	6.72	0.05	8.4	1.6	73.6	0.02	0.92	0.02	0.58	90.22
Fishing Bridge to West Thumb	0.08	26.88	0.46	77.28	0.3	13.8	0.02	0.92	0.7	20.3	139.18
Madison to Old Faithful	1.41	473.76	0.47	78.96	0.1	4.6	1.15	52.9	1.05	30.45	640.67
Old Faithful to West Thumb	0.27	90.72	1.35	226.8	0.2	9.2	0.05	2.3	0.75	21.75	350.77
West Thumb to Flagg Ranch	0.05	16.8	1.75	294	0.1	4.6	0.05	2.3	0.05	1.45	319.15

Snowcoaches	West Entrance 44		South Entrance 13		East Entrance 3		North Entrance 17		Old Faithful 23		Total 100
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	2.2	0.03	0.39	0.1	0.3	1.8	30.6	0	0	33.49
West Entrance to Madison	1.8	79.2	0.05	0.65	0.1	0.3	0.15	2.55	0.48	11.04	93.74
Madison to Norris	0.59	25.96	0.08	1.04	0.1	0.3	1.2	20.4	0.06	1.38	49.08
Norris to Canyon Village	0.44	19.36	0.05	0.65	0.2	0.6	0.56	9.52	0.06	1.38	31.51
Canyon Village to Fishing Bridge	0.34	14.96	0.45	5.85	1.4	4.2	0.36	6.12	0.06	1.38	32.51
Fishing Bridge to East Entrance	0.02	0.88	0.05	0.65	1.6	4.8	0.02	0.34	0	0	6.67
Fishing Bridge to West Thumb	0.08	3.52	0.46	5.98	0.3	0.9	0.02	0.34	0.06	1.38	12.12
Madison to Old Faithful	1.41	62.04	0.47	6.11	0.1	0.3	1.15	19.55	0.6	13.8	101.8
Old Faithful to West Thumb	0.27	11.88	1.35	17.55	0.2	0.6	0.05	0.85	1.3	29.9	60.78
West Thumb to Flagg Ranch	0.05	2.2	1.75	22.75	0.1	0.3	0.05	0.85	1.18	27.14	53.24

Snowmobiles	CDST 50		Grassy Lake Rd 50		Jackson Lake 40		Totals 140
GRTE Road Segment	Factor	Results	Factor	Results	Factor	Results	
Moran Junction to Flagg Ranch	2	100	0	0	0	0	100
Flagg Ranch west to boundary	0	0	1.9	95	0	0	95
Jackson Lake fishing access	0	0	0	0	2	80	80

Note:

20% of snowmobile entries for this alternative are modeled as unguided, and would be required to enter the park no later than 10:30 a.m. These entries are included in the overall numbers for each entrance.

This alternative also allows up to 626 commercial snowmobiles and 100 snowcoaches per day to account for increased seasonal demand. These increased allowances count against a seasonal limit of 27,540 snowmobiles/5,291 snowcoaches.

YELL group sizes are modeled at 11 snowmobiles/guided group

YELL group sizes are modeled at 5 snowmobiles/unguided group

GRTE group sizes are modeled at 5, except Jackson Lake which is modeled as a single user

Alternative 6 - Mixed Use

Snowmobiles	West Entrance		South Entrance		East Entrance		North Entrance		OF/Norris		Total
	0		250		0		0		100		350
Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0	0	0	0	0	0	0	0	0	0	0
West Entrance to Madison	0	0	0	0	0	0	0	0	0	0	0
Madison to Norris	0	0	0	0	0	0	0	0	0	0	0
Norris to Canyon Village	1.5	0	0.02	5	0	0	0	0	0.1	10	15
Canyon Village to Fishing Bridge	1.4	0	0.38	95	0	0	0	0	1.7	170	265
Fishing Bridge to Lake Butte	0	0	0	0	0	0	0	0	0	0	0
Fishing Bridge to West Thumb	0.5	0	0.44	110	0	0	0	0	1.7	170	280
Madison to Old Faithful	0	0	0	0	0	0	0	0	0	0	0
Old Faithful to West Thumb	0.48	0	1.42	355	0	0	0	0	1.8	180	535
West Thumb to Flagg Ranch	0.02	0	1.8	450	0	0	0	0	0.1	10	460
GTNP CDST											
GTNP Grassy											
GTNP Jackson Lake											

Snowcoaches	West Entrance		South Entrance		East Entrance		North Entrance		OF/Norris		Total
	0		10		0		0		30		40
	(Start @ Norris)										
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0	0	0	0	0	0	0	0	0	0	0
West Entrance to Madison	0	0	0	0	0	0	0	0	0	0	0
Madison to Norris	0	0	0	0	0	0	0	0	0	0	0
Norris to Canyon Village	1.5	0	0.02	0.2	0	0	0	0	0.1	3	3.2
Canyon Village to Fishing Bridge	1.4	0	0.38	3.8	0	0	0	0	1.7	51	54.8
Fishing Bridge to Lake Butte	0	0	0	0	0	0	0	0	0	0	0
Fishing Bridge to West Thumb	0.48	0	0.44	4.4	0	0	0	0	1.7	51	55.4
Madison to Old Faithful	0	0	0	0	0	0	0	0	0	0	0
Old Faithful to West Thumb	0.46	0	1.42	14.2	0	0	0	0	1.8	54	68.2
West Thumb to Flagg Ranch	0.02	0	1.8	18	0	0	0	0	0.1	3	21

Wheeled Vehicles	West Entrance		South Entrance		East Entrance		North Entrance		Old Faithful		Total
	75		0		0		25		0		100
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.3	22.5	0	0	0	0	1.8	45	0.2	0	67.5
West Entrance to Madison	1.7	127.5	0	0	0	0	0.25	6.25	0.8	0	133.75
Madison to Norris	0.4	30	0	0	0	0	1.55	38.75	0.2	0	68.75
Norris to Canyon Village	0	0	0	0	0	0	0	0	0	0	0
Canyon Village to Fishing Bridge	0	0	0	0	0	0	0	0	0	0	0
Fishing Bridge to Lake Butte	0	0	0	0	0	0	0	0	0	0	0
Fishing Bridge to West Thumb	0	0	0	0	0	0	0	0	0	0	0
Madison to Old Faithful	1.5	112.5	0	0	0	0	1.5	37.5	1	0	150
Old Faithful to West Thumb	0	0	0	0	0	0	0	0	0	0	0
West Thumb to Flagg Ranch	0	0	0	0	0	0	0	0	0	0	0

Snowmobiles	CDST		Grassy Lake Rd		Jackson Lake		Totals
	0		50		40		90
GRTE Road Segment	Factor	Results	Factor	Results	Factor	Results	
Moran Junction to Flagg Ranch	0	0	0	0	0	0	0
Flagg Ranch west to boundary	0	0	1.9	95	0	0	95
Jackson Lake fishing access	0	0	0	0	2	80	80

Note:

YELL group sizes are modeled at 90% 8 snowmobiles/group and 10% would be 17 snowmobiles/group.
GRTE group sizes are modeled at 5, except Jackson Lake which is modeled as a single user.

Current Conditions/Actual Use

Snowmobiles	West Entrance 153		South Entrance 89		East Entrance 8		North Entrance 5		Old Faithful 5		Total 260
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	7.65	0.03	2.67	0.1	0.8	1.8	9	0.3	1.5	21.62
West Entrance to Madison	1.8	275.4	0.05	4.45	0.1	0.8	0.15	0.75	0.15	0.75	282.15
Madison to Norris	0.59	90.27	0.08	7.12	0.1	0.8	1.2	6	1	5	109.19
Norris to Canyon Village	0.44	67.32	0.05	4.45	0.2	1.6	0.56	2.8	0.7	3.5	79.67
Canyon Village to Fishing Bridge	0.34	52.02	0.45	40.05	1.4	11.2	0.36	1.8	0.7	3.5	108.57
Fishing Bridge to East Entrance	0.02	3.06	0.05	4.45	1.6	12.8	0.02	0.1	0.02	0.1	20.51
Fishing Bridge to West Thumb	0.08	12.24	0.46	40.94	0.3	2.4	0.02	0.1	0.7	3.5	59.18
Madison to Old Faithful	1.41	215.73	0.47	41.83	0.1	0.8	1.15	5.75	1.05	5.25	269.36
Old Faithful to West Thumb	0.27	41.31	1.35	120.15	0.2	1.6	0.05	0.25	0.75	3.75	167.06
West Thumb to Flagg Ranch	0.05	7.65	1.75	155.75	0.1	0.8	0.05	0.25	0.05	0.25	164.7

Snowcoaches	West Entrance 14		South Entrance 5		East Entrance 1		North Entrance 6		Old Faithful 3		Total 29
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	0.7	0.03	0.15	0.1	0.1	1.8	10.8	0	0	11.75
West Entrance to Madison	1.8	25.2	0.05	0.25	0.1	0.1	0.15	0.9	0.48	1.44	27.89
Madison to Norris	0.59	8.26	0.08	0.4	0.1	0.1	1.2	7.2	0.06	0.18	16.14
Norris to Canyon Village	0.44	6.16	0.05	0.25	0.2	0.2	0.56	3.36	0.06	0.18	10.15
Canyon Village to Fishing Bridge	0.34	4.76	0.45	2.25	1.4	1.4	0.36	2.16	0.06	0.18	10.75
Fishing Bridge to East Entrance	0.02	0.28	0.05	0.25	1.6	1.6	0.02	0.12	0	0	2.25
Fishing Bridge to West Thumb	0.08	1.12	0.46	2.3	0.3	0.3	0.02	0.12	0.06	0.18	4.02
Madison to Old Faithful	1.41	19.74	0.47	2.35	0.1	0.1	1.15	6.9	0.6	1.8	30.89
Old Faithful to West Thumb	0.27	3.78	1.35	6.75	0.2	0.2	0.05	0.3	1.3	3.9	14.93
West Thumb to Flagg Ranch	0.05	0.7	1.75	8.75	0.1	0.1	0.05	0.3	1.18	3.54	13.39

Snowmobiles	CDST 0		Grassy Lake Rd 20		Jackson Lake 10		Totals 30
GRTE Road Segment	Factor	Results	Factor	Results	Factor	Results	
Moran Junction to Flagg Ranch	0	0	0	0	0	0	0
Flagg Ranch west to boundary	0	0	1.9	38	0	0	38
Jackson Lake fishing access	0	0	0	0	2	20	20

Note:

This alternative models the average numbers of snowmobile and snowcoach daily entries over the following winter seasons:

2003-2004

2004-2005

2005-2006

For snowcoaches, this alternative models emissions of the 2005-2006 fleet.

YELL group sizes are modeled at 7 snowmobiles/group

GRTE group sizes are modeled at 5, except Jackson Lake which is modeled as a single user

Historical Unregulated Conditions

Snowmobiles	West Entrance 947		South Entrance 310		East Entrance 62		North Entrance 28		Old Faithful 53		Total 1400
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	47.35	0.03	9.3	0.1	6.2	1.8	50.4	0.3	15.9	129.15
West Entrance to Madison	1.8	1704.6	0.05	15.5	0.1	6.2	0.15	4.2	0.15	7.95	1738.45
Madison to Norris	0.59	558.73	0.08	24.8	0.1	6.2	1.2	33.6	1	53	676.33
Norris to Canyon Village	0.44	416.68	0.05	15.5	0.2	12.4	0.56	15.68	0.7	37.1	497.36
Canyon Village to Fishing Bridge	0.34	321.98	0.45	139.5	1.4	86.8	0.36	10.08	0.7	37.1	595.46
Fishing Bridge to East Entrance	0.02	18.94	0.05	15.5	1.6	99.2	0.02	0.56	0.02	1.06	135.26
Fishing Bridge to West Thumb	0.08	75.76	0.46	142.6	0.3	18.6	0.02	0.56	0.7	37.1	274.62
Madison to Old Faithful	1.41	1335.27	0.47	145.7	0.1	6.2	1.15	32.2	1.05	55.65	1575.02
Old Faithful to West Thumb	0.27	255.69	1.35	418.5	0.2	12.4	0.05	1.4	0.75	39.75	727.74
West Thumb to Flagg Ranch	0.05	47.35	1.75	542.5	0.1	6.2	0.05	1.4	0.05	2.65	600.1

Snowcoaches	West Entrance 20		South Entrance 7		East Entrance 1		North Entrance 5		Old Faithful 7		Total 40
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	1	0.03	0.21	0.1	0.1	1.8	9	0	0	10.31
West Entrance to Madison	1.8	36	0.05	0.35	0.1	0.1	0.15	0.75	0.48	3.36	40.56
Madison to Norris	0.59	11.8	0.08	0.56	0.1	0.1	1.2	6	0.06	0.42	18.88
Norris to Canyon Village	0.44	8.8	0.05	0.35	0.2	0.2	0.56	2.8	0.06	0.42	12.57
Canyon Village to Fishing Bridge	0.34	6.8	0.45	3.15	1.4	1.4	0.36	1.8	0.06	0.42	13.57
Fishing Bridge to East Entrance	0.02	0.4	0.05	0.35	1.6	1.6	0.02	0.1	0	0	2.45
Fishing Bridge to West Thumb	0.08	1.6	0.46	3.22	0.3	0.3	0.02	0.1	0.06	0.42	5.64
Madison to Old Faithful	1.41	28.2	0.47	3.29	0.1	0.1	1.15	5.75	0.6	4.2	41.54
Old Faithful to West Thumb	0.27	5.4	1.35	9.45	0.2	0.2	0.05	0.25	1.3	9.1	24.4
West Thumb to Flagg Ranch	0.05	1	1.75	12.25	0.1	0.1	0.05	0.25	1.18	8.26	21.86

Snowmobiles	CDST 60		Grassy Lake Rd 45		Jackson Lake 60		Totals 165
GRTE Road Segment	Factor	Results	Factor	Results	Factor	Results	
Moran Junction to Flagg Ranch	2	120	0	0	0	0	120
Flagg Ranch west to boundary	0	0	1.9	85.5	0	0	85.5
Jackson Lake fishing access	0	0	0	0	2	120	120

Note:

For snowcoaches, this alternative models the fleet circa 1999.

YELL group sizes are modeled at 5 snowmobiles/group.

GRTE group sizes are modeled at 5, except Jackson Lake which is modeled as a single user.

Oversnow Vehicle Miles Traveled Per Day, by Scenario and Road Segment (including miles for Jackson Lake OSV travel)

Road Segment	Mileage	Alternative 1a		Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6			Historical		Current Conditions		Alternative 1b		Alternative 1d		Alternative 1e	
		Snwmb	Coach	Snwmb	Coach	Snwmb	Coach	Snwmb	Coach	Snwmb	Coach	Snwmb	Coach	Wheeled	Snwmb	Coach	Snwmb	Coach	Snwmb	Coach	Snwmb	Coach	Snwmb	Coach
Mammoth to Norris	21	1965.60	35.70	0.00	716.10	0.00	0.00	2257.50	717.57	2476.74	703.29	0.00	0.00	1417.50	2712.15	216.51	454.02	246.75	1488.48	535.29	1881.60	535.29	1818.60	605.64
West Entrance to Madison	14	10416.00	856.80	0.00	1593.76	0.00	0.00	15592.50	1477.28	8806.70	1312.36	0.00	0.00	1872.50	24338.30	567.84	3950.10	390.46	10948.00	1014.16	10360.00	1014.16	10522.40	954.24
Madison to Norris	14	4530.40	280.84	0.00	787.22	0.00	0.00	6496.00	747.04	4206.72	687.12	0.00	0.00	962.50	9468.62	264.32	1528.66	225.96	4404.96	528.92	4474.40	528.92	0.00	0.00
Norris to Canyon Village	12	2793.60	179.52	0.00	436.20	0.00	0.00	4146.00	418.92	2538.00	378.12	180.00	38.40	0.00	5968.32	150.84	956.04	121.80	2694.72	287.64	2697.60	287.64	823.20	252.48
Canyon Village to Fishing Bridge	16	5164.80	184.96	0.00	599.20	0.00	0.00	8008.00	641.76	4657.60	520.16	4240.00	876.80	0.00	9527.36	217.12	1737.12	172.00	4488.96	370.72	4268.80	370.72	2630.40	640.96
Fishing Bridge to East Entrance*	27	2273.40	18.36	0.00	72.63	0.00	0.00	5022.00	277.83	2435.94	180.09	0.00	0.00	0.00	3652.02	66.15	553.77	60.75	220.80	15.90	202.00	15.90	202.00	15.90
Fishing Bridge to West Thumb	21	3502.80	57.12	0.00	370.02	0.00	0.00	4798.50	336.42	2922.78	254.52	5880.00	1163.40	0.00	5767.02	118.44	1242.78	84.42	3487.68	210.84	3250.80	210.84	4128.60	737.94
Madison to Old Faithful	16	11798.40	767.04	0.00	1962.40	0.00	0.00	16876.00	1822.08	10250.72	1628.80	0.00	0.00	2400.00	25200.32	664.64	4309.76	494.24	12194.56	1276.80	11734.40	1276.80	13481.60	1202.56
Old Faithful to West Thumb	17	7429.00	156.06	0.00	1348.95	8500.00	680.00	9490.25	1227.40	5963.09	1033.26	9095.00	1159.40	0.00	12371.58	414.80	2840.02	253.81	8093.36	863.26	7293.00	863.26	8950.50	991.61
West Thumb to Flagg Ranch	24	9888.00	40.80	0.00	1787.76	12000.00	960.00	11550.00	1570.08	7659.60	1277.76	11040.00	504.00	0.00	14402.40	524.64	3952.80	321.36	11923.20	1112.16	10320.00	1112.16	10250.40	655.44
GTNP CDST (Moran to Flagg)	24	2400.00		0.00		0.00		3600.00		2400.00		0.00			2880.00		0.00		2400.00		2400.00		2400.00	
GTNP Grassy (Flagg Ranch/west to ID)	7	665.00		0.00		700.00		997.50		665.00		665.00			598.50		266.00		665.00		665.00		665.00	
GTNP Jackson Lake (fishing access)	37.3	2984.00		0.00		0.00		7460.00		2984.00		2984.00			4476.00		746.00		2984.00		2984.00		2984.00	
Sub Totals		65811.0	2577.2	0.0	9674.2	21200.0	1640.0	96294.3	9236.4	57966.9	7975.5	34084.0	3742.0	6652.5	121362.6	3205.3	22537.1	2371.6	65993.7	6215.7	62531.6	6215.7	58856.7	6056.8
Total Alternative Vehicle Miles in a Day		68,388		9,674		22,840		105,531		65,942		44,479			124,568		24,909		72,209		68,747		64,913	

*For alternatives where East Entrance is closed a mileage of 10 rather than 27 was calculated for this road segment.

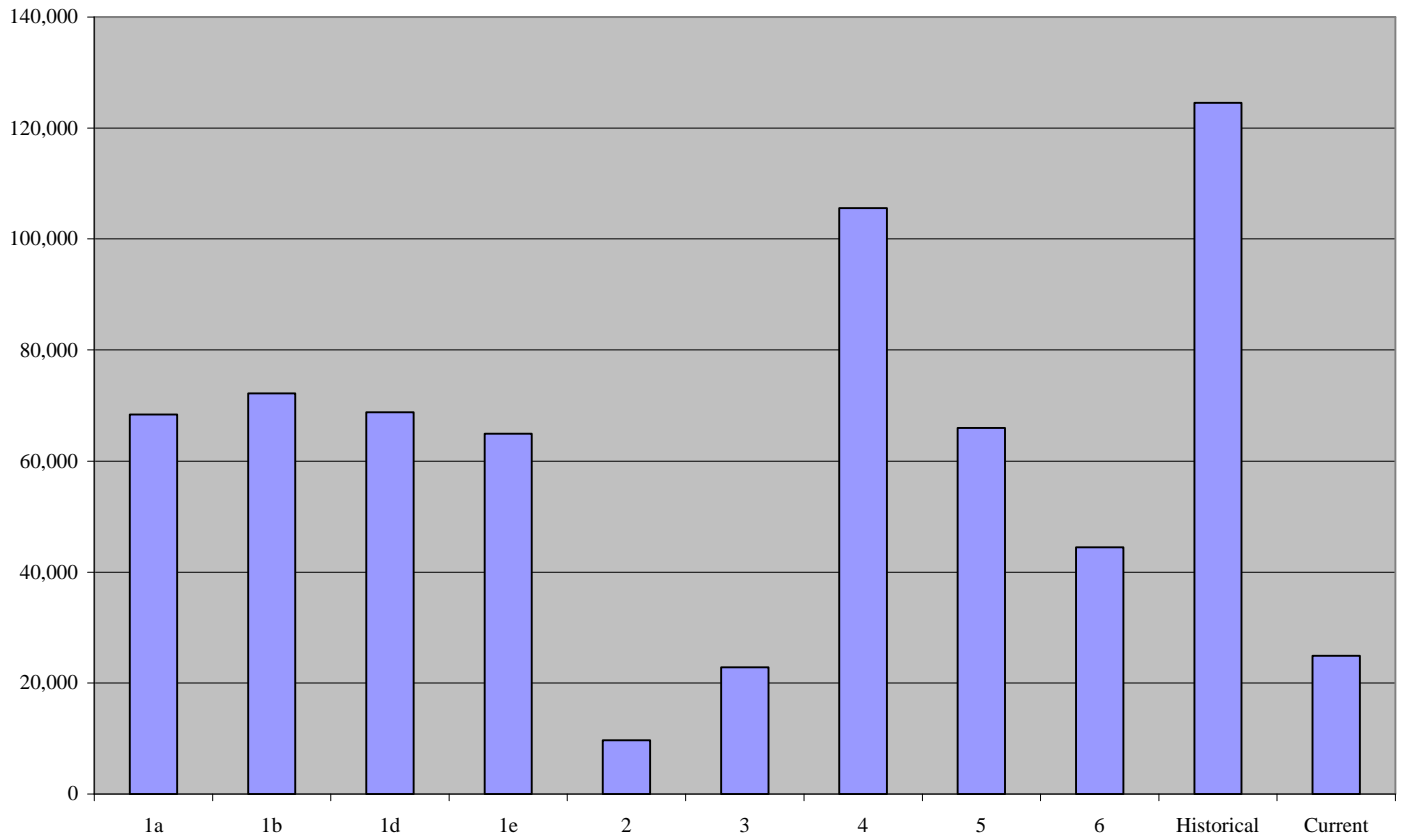
A-17

Figures for Chart		
Alternative	1a	68,388
Alternative	1b	72,209
Alternative	1d	68,747
Alternative	1e	64,913
Alternative	2	9,674
Alternative	3	22,840
Alternative	4	105,531
Alternative	5	65,942
Alternative	6	44,479
Alternative	Historical	124,568
Alternative	Current	24,909

Jackson Lake miles by segment origin					
Segment	Percent use:	Signal Mtn.	Percent use:	Colter Bay	
1	20	5677.2	15	1012.6	
2	30	918.6	5	5753.9	
3	10	7223.0	17.5	3199.6	
4	10	663.1	17.5	2022.2	
5	10	3004.6	5	2855.2	
6	15	1998.0	5	980.5	
7	5	2999.5	5	2933.0	
8	n/a	1629.6	20	6584.5	
9	n/a	818.7	5	2655.1	
10	n/a	2425.7	5	4590.7	
		27358.0		32587.3	meters
		17.0		20.3	miles

17/37.3 = 46% travel originates at Signal Mtn.
20.3/37.3 = 54% travel originates at Colter Bay

OSV miles traveled per day, by alternative



APPENDIX B
SNOWMOBILE EMISSIONS

		2-Stroke CO and HC Engine Data and Emissions Factors												
													14-Feb-06	
Mode		hp	kW	mi/hr	CO	CO		hp	kW	mi/hr	HC	HC		
	A 11-3				g/hr	g/mi		A 11-3			g/hr	g/mi		
1		58.8	43.84716	79.125163	18172.2	229.66398		58.8	43.84716	79.125163	4203.49	53.1245665		
2	0.384976	28.4	16.880106	48.3537	13078.4	270.47361	0.384976	28.4	16.880106	48.3537	3853.28	79.6894548		
3	0.2085997	15.5	9.1465031	29.854646	8234.4	275.81637	0.2085997	15.5	9.1465031	29.854646	3365.01	112.713111		
4	0.1075723	7.1	4.716738	15.763283	4384.4	278.14004	0.1075723	7.1	4.716738	15.763283	3400.93	215.750112		
5	0.0030105	0.7	0.1320002	NA	312.2	NA	0.0030105	0.7	0.1320002	NA	538.38	NA		
	A 11-4							A 11-4						
1		61.9	46.15883	81.408936	19019.6	233.63037		61.9	46.15883	81.408936	3997	49.0978044		
2	0.457483	26.9	20.05933	46.387068	12769.4	275.27931	0.457483	26.9	20.05933	46.387068	3883.13	83.7114774		
3	0.2755102	16.2	12.08034	30.953561	7634.6	246.6469	0.2755102	16.2	12.08034	30.953561	3139.73	101.433564		
4	0.122449	7.2	5.36904	15.941101	1833.2	114.99833	0.122449	7.2	5.36904	15.941101	1556.35	97.6312727		
5	0.0187075	1.1	0.82027	NA	309.2	NA	0.0187075	1.1	0.82027	NA	523.35	NA		
	W 11-1							W 11-1						
1		57	42.5049	77.734811	16468.1	211.84975		57	42.5049	77.734811	3979.83	51.1975258		
2	0.4234694	24.9	18.56793	43.69155	9041.7	206.94391	0.4234694	24.9	18.56793	43.69155	3228	73.8815633		
3	0.2414966	14.2	10.58894	27.783646	5347.7	192.47654	0.2414966	14.2	10.58894	27.783646	2485.81	89.4702604		
4	0.122449	7.2	5.36904	15.941101	3220.5	202.02494	0.122449	7.2	5.36904	15.941101	2486.6	155.986714		
5	0.0001701	0.01	0.007457	NA	135.4	NA	0.0001701	0.01	0.007457	NA	379.76	NA		
	W 11-2							W 11-2						
1		56.7	42.28119	77.498386	16456.8	212.35023		56.7	42.28119	77.498386	3939.86	50.8379617		
2	0.4251701	25	18.6425	43.828338	9590.5	218.81962	0.4251701	25	18.6425	43.828338	3391.67	77.3853218		
3	0.2482993	14.6	10.88722	28.425071	5303.3	186.57121	0.2482993	14.6	10.88722	28.425071	2590.38	91.1301159		
4	0.122449	7.2	5.36904	15.941101	4576.4	287.0818	0.122449	7.2	5.36904	15.941101	3985.72	250.027896		
5	0.0001701	0.01	0.007457	NA	307.3	NA	0.0001701	0.01	0.007457	NA	452	NA		
Average Mode 2, 35 mph				45.565164	242.9		Average Mode 2, 35 mph			45.565164	78.7			
Average Mode 4, 15 mph				15.896647	220.6		Average Mode 4, 15 mph			15.896647	179.8			
Average Mode 5, Idle				266.0				Average Mode 5, Idle			473.4			

2-Stroke NOx and PM Engine Data and Emissions Factors												
												14-Feb-06
Mode		hp	kW	mi/hr	NOx g/hr	NOx g/mi		hp	kW	mi/hr	PM g/hr	PM g/mi
	A 11-3							A 11-3				
1		58.8	43.84716	79.125163		0		58.8	43.84716	79.125163		0
2	0.384976	28.4	16.880106	48.3537	9.2	0.1902647	0.384976	28.4	16.880106	48.3537	27.3	0.5645897
3	0.2085997	15.5	9.1465031	29.854646		0	0.2085997	15.5	9.1465031	29.854646		0
4	0.1075723	7.1	4.716738	15.763283	3.4	0.2156911	0.1075723	7.1	4.716738	15.763283	48.53	3.0786735
5	0.0030105	0.7	0.1320002	NA	0.4	NA	0.0030105	0.7	0.1320002	NA	0.74	NA
	A 11-4							A 11-4				
1		61.9	46.15883	81.408936		0		61.9	46.15883	81.408936		0
2	0.457483	26.9	20.05933	46.387068	8.9	0.1918638	0.457483	26.9	20.05933	46.387068	25.92	0.5587764
3	0.2755102	16.2	12.08034	30.953561		0	0.2755102	16.2	12.08034	30.953561		0
4	0.122449	7.2	5.36904	15.941101	2.5	0.1568273	0.122449	7.2	5.36904	15.941101	21.89	1.3731799
5	0.0187075	1.1	0.82027	NA	0.3	NA	0.0187075	1.1	0.82027	NA	0.49	NA
	W 11-1							W 11-1				
1		57	42.5049	77.734811		0		57	42.5049	77.734811		0
2	0.4234694	24.9	18.56793	43.69155	12.2	0.2792302	0.4234694	24.9	18.56793	43.69155	60	1.3732633
3	0.2414966	14.2	10.58894	27.783646		0	0.2414966	14.2	10.58894	27.783646		0
4	0.122449	7.2	5.36904	15.941101	3.5	0.2195582	0.122449	7.2	5.36904	15.941101	67.83	4.2550385
5	0.0001701	0.01	0.007457	NA	0.8	NA	0.0001701	0.01	0.007457	NA	4.21	NA
	W 11-2							W 11-2				
1		56.7	42.28119	77.498386		0		56.7	42.28119	77.498386		0
2	0.4251701	25	18.6425	43.828338	10.8	0.2464159	0.4251701	25	18.6425	43.828338	69.88	1.5944023
3	0.2482993	14.6	10.88722	28.425071		0	0.2482993	14.6	10.88722	28.425071		0
4	0.122449	7.2	5.36904	15.941101	3	0.1881928	0.122449	7.2	5.36904	15.941101	107.26	6.7285189
5	0.0001701	0.01	0.007457	NA	0.6	NA	0.0001701	0.01	0.007457	NA	9.65	NA
Average Mode 2, 35 mph				45.565164		0.23	Average Mode 2, 35 mph			45.565164		1.02
Average Mode 4, 15 mph				15.896647		0.20	Average Mode 4, 15 mph			15.896647		3.86
Average Mode 5, Idle					0.53		Average Mode 5, Idle				3.77	

4-Stroke Snowmobile												
CO & HC Engine Modal Test Data and Emissions Factors												
												14-Feb-06
Mode		hp	kW	mi/hr	CO	CO			hp	kW	mi/hr	HC
	Engine 1				g/hr	g/mi		Engine 1				g/hr
1		51.640357	38.508214	73.302343	7514.7778	102.51757			51.640357	38.508214	73.302343	175.76083
2	0.4383508	22.636591	16.880106	40.538095	547.35068	13.502131		0.4383508	22.636591	16.880106	40.538095	94.532863
3	0.2375208	12.265661	9.1465031	24.628722	313.63306	12.734443		0.2375208	12.265661	9.1465031	24.628722	50.940697
4	0.1224865	6.3252488	4.716738	14.377211	188.61753	13.119202		0.1224865	6.3252488	4.716738	14.377211	40.036452
5	0.0034278	0.1770151	0.1320002	NA	135.76942	NA		0.0034278	0.1770151	0.1320002	NA	16.567461
	Engine 2							Engine 2				
1		51.50865	38.41	73.187733	7810	106.71187			51.50865	38.41	73.187733	240
2	0.4406852	22.757141	16.97	40.708839	539	13.240368		0.4406852	22.757141	16.97	40.708839	127
3	0.2415069	12.471503	9.3	24.968661	340	13.61707		0.2415069	12.471503	9.3	24.968661	69
4	0.1225713	6.3296232	4.72	14.385079	205	14.250878		0.1225713	6.3296232	4.72	14.385079	54
5	0.0018178	0.0938715	0.07	NA	130	NA		0.0018178	0.0938715	0.07	NA	16
	Engine 3							Engine 3				
1	36.6	49.0814	36.6	71.025124		0		36.6	49.0814	36.6	71.025124	0
2	16.043639	21.51487	16.043639	38.934108	545	13.998009		16.043639	21.51487	16.043639	38.934108	77.7
3	8.6932624	11.657855	8.6932624	23.61907		0		8.6932624	11.657855	8.6932624	23.61907	0
4	4.4830074	6.011811	4.4830074	13.812202	341	24.688316		4.4830074	6.011811	4.4830074	13.812202	35.6
5	0.1254591	0.1682434	0.1254591	NA	75	NA		0.1254591	0.1682434	0.1254591	NA	26.2
	Engine 4							Engine 4				
1	63.8	75.901837	56.6	90.126653		0		63.8	75.901837	56.6	90.126653	0
2	27.96678	32.855036	24.5	53.923579	2358.97	43.74654		27.96678	32.855036	24.5	53.923579	124.01
3	15.153829	18.774306	14	34.898401		0		15.153829	18.774306	14	34.898401	0
4	7.8146414	9.387153	7	19.768608	1095.18	55.399955		7.8146414	9.387153	7	19.768608	42.12
5	0.2186965	0.2932768	0.2186965	NA	409.41	NA		0.2186965	0.2932768	0.2186965	NA	67.84
	Engine 5							Engine 5				
1	63.8	75.901837	56.6	90.126653		0		63.8	75.901837	56.6	90.126653	0
2	28.115715	32.855036	24.5	53.923579	2091.92	38.794161		28.115715	32.855036	24.5	53.923579	116.6
3	15.408141	18.774306	14	34.898401		0		15.408141	18.774306	14	34.898401	0
4	7.8200458	9.387153	7	19.768608	1551.51	78.483522		7.8200458	9.387153	7	19.768608	60.81
5	0.1159753	0.1555254	0.1159753	NA	323.64	NA		0.1159753	0.1555254	0.1159753	NA	58.86
Average Mode 2, 35 mph				45.60564		22.9		Average Mode 2, 35 mph				45.60564
Average Mode 4, 15 mph				16.422341		35.1		Average Mode 4, 15 mph				16.422341
Average Mode 5, Idle					191.5			Average Mode 5, Idle				35.3

4-Stroke Snowmobile						
NOx Engine Modal Test Data and Emissions Factors						
						14-Feb-06
Mode		hp	kW	mi/hr	NOx g/hr	NOx g/mi
	Engine 1					
1		51.640357	38.508214	73.302343		0
2	0.4383508	22.636591	16.880106	40.538095	292	7.2031011
3	0.2375208	12.265661	9.1465031	24.628722		0
4	0.1224865	6.3252488	4.716738	14.377211	74	5.1470346
5	0.0034278	0.1770151	0.1320002	NA	0	NA
	Engine 2					
1		51.50865	38.41	73.187733		0
2	0.4406852	22.757141	16.97	40.708839	328	8.0572182
3	0.2415069	12.471503	9.3	24.968661		0
4	0.1225713	6.3296232	4.72	14.385079	91	6.3259995
5	0.0018178	0.0938715	0.07	NA	0	NA
	Engine 3					
1	36.6	49.0814	36.6	71.025124		0
2	16.043639	21.51487	16.043639	38.934108	208.41	5.35289
3	8.6932624	11.657855	8.6932624	23.61907		0
4	4.4830074	6.011811	4.4830074	13.812202	16.47	1.1924239
5	0.1254591	0.1682434	0.1254591	NA	0.7	NA
	Engine 4					
1	63.8	75.901837	56.6	90.126653		0
2	27.96678	32.855036	24.5	53.923579	217.51	4.0336714
3	15.153829	18.774306	14	34.898401		0
4	7.8146414	9.387153	7	19.768608	23.31	1.1791422
5	0.2186965	0.2932768	0.2186965	NA	1.29	NA
	Engine 5					
1	63.8	75.901837	56.6	90.126653		0
2	28.115715	32.855036	24.5	53.923579	207.86	3.8547144
3	15.408141	18.774306	14	34.898401		0
4	7.8200458	9.387153	7	19.768608	34.46	1.7431677
5	0.1159753	0.1555254	0.1159753	NA	1.03	NA
Average Mode 2, 35 mph				45.60564		5.64
Average Mode 4, 15 mph				16.422341		2.80
Average Mode 5, Idle					0.93	

	4-Stroke Snowmobile						
	PM Engine Modal Test Data and Emissions Factors						
						14-Feb-06	
	Mode		hp	mi/hr		PM	
	Arctic Cat Test 1				g/hr	g/mi	
	1		41.1	63.2		1.40	0.022
	2		17.9	33.6		0.79	0.024
	3		10.2	21.2		0.82	0.039
	4		4.9	11.8		0.74	0.063
	5		0	NA		0.47	NA
	Arctic Cat Test 2						
	1		41.3	63.4		1.42	0.022
	2		18	33.7		1.09	0.032
	3		10.3	21.3		1.00	0.047
	4		4.9	11.8		0.71	0.060
	5		0	NA		0.40	NA
	Polaris Test 1						
	1		43.6	65.8		3.84	0.058
	2		18.9	35.1		1.25	0.036
	3		10.8	22.2		0.96	0.043
	4		5.5	12.9		0.95	0.074
	5		0	NA		0.72	NA
	Polaris Test 2						
	1		44.3	66.5		2.61	0.039
	2		19.4	35.8		1.15	0.032
	3		9.5	20.0		0.94	0.047
	4		5.5	12.9		0.79	0.061
	5		0	NA		0.35	NA
	Average Mode 2, 35 mph			34.6			0.031
	Average Mode 4, 15 mph			12.3			0.065
	Average Mode 5, Idle					0.49	
Based on 2002 4-stroke Arctic Cat Touring & Polaris Frontier Engine Dynamometer Test Results (Two Tests each with Reference Gasoline)							
Source:	Test results: <i>Laboratory Testing of Snowmobile Emissions</i> , Lela & White, SwRI July 2002						

SNOWMOBILE IMPROVED BAT

Yellowstone National Park Proposed Improved BAT Snowmobile Emission Requirements Based on 2002 Polaris 4-stroke Frontier Engine Dynamometer Test Results (Two Tests with Reference Gasoline)

Mode Test 1	hp	mi/hr	CO		HC		NOx		PM		
			g/hr	g/mi	g/hr	g/mi	g/hr	g/mi	g/hr	g/mi	
1	43.6	65.8	5509.6	83.8	167.65	2.55	228.7	3.48	3.84	0.058	
2	18.9	35.1	411.5	11.7	36.17	1.03	123.7	3.53	1.25	0.036	
3	10.8	22.2	278.3	12.5	10.77	0.49	38.1	1.72	0.96	0.043	
4	5.5	12.9	239.9	18.6	7.6	0.59	9.8	0.76	0.95	0.074	
5	0	NA	136.9	NA	34.48	NA	1	NA	0.72	NA	
Test 2											
1	44.3	66.5	4729.8	71.1	156.95	2.36	291	4.38	2.61	0.039	
2	19.4	35.8	347.2	9.7	27.48	0.77	109.6	3.06	1.15	0.032	
3	9.5	20.0	281.6	14.1	12.36	0.62	41.4	2.07	0.94	0.047	
4	5.5	12.9	233.1	18.1	6.94	0.54	13.6	1.06	0.79	0.061	
5	0	NA	138.2	NA	36.05	NA	1.1	NA	0.35	NA	
Average Mode 2, 35 mph		35.5	10.7		0.90		3.29		0.034		
Average Mode 4, 15 mph		12.9	18.4		0.56		0.91		0.068		
Average Mode 5, Idle			137.6		35.3		1.05		0.54		

Source: Test results: *Laboratory Testing of Snowmobile Emissions*, Lela & White, SwRI July 2002

APPENDIX C
SNOWCOACH EMISSIONS

APPENDIX C
CURRENT FLEET SNOWCOACH EMISSIONS FOR MODELING PURPOSES
Composite Emission Factors - Weighted by Yellowstone Fleet Mix

12-Jun-06

Fleet Average	Idle (g/hr)	Low Speed (g/mile)	Cruise Speed (g/mile)
CO	441.5	164.1	254.2
HC*	24.6	5.4	10.9
NOx	3.9	15.9	15.6
PM-10**	0.11	0.06	0.05

Yellowstone Snowcoach Categories	Number in Commercial Fleet***	2005	2006
Type 1 Diesels	4	NPS Van	NPS Bus
Type 2 Old Bombardiers - 5.7L V-8 Carbureted	27	Xanterra 709	AG Kitty
Type 3 Retrofitted Bombardiers - 5.3L V-8 Fuel-injected	3	Alpen Guides	AG Cygnet
Type 4 Dodge 5.2L V-8 Fuel-injected	6	-	YEXP R250 & R350
Type 5 GMC 5.7L V-8 Fuel-injected	9	Xanterra 163-66	-
Type 6 Ford 6.8L V-10 Fuel-injected	23	-	BBC, YSCT & 3BL
Type 7 GMC 8.1L V-8 Fuel-injected	4	Xanterra 419	-
Type 8 GMC 6.0L V-8 Fuel-injected	6	Xanterra 416	-
Total (all types)	82		

Note: *HC emissions for Type 1 from MOBILE6 HDDV5. HC emissions were not measured for the NPS diesel van and bus sampled.

**PM-10 emissions for Type 2-8 from MOBILE6 LDGT4. PM emissions were not measured for any gasoline snowcoaches.

***Snowcoaches authorized to operate in Yellowstone, 2005-06 winter.

Weighting assumes all vehicles in the fleet are operated with equal frequency/time period.

Source: *In-use Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park*
 Bishop, Burgard, Dalton, and Stedman, University of Denver, January 2006
Potable Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park
 Bishop, Stadtmuller, and Stedman, University of Denver, May 2006

APPENDIX C
1999 FLEET SNOWCOACH EMISSIONS FOR MODELING PURPOSES
Composite Emission Factors - Weighted by Yellowstone Fleet Mix (Pre-2000 Vehicles only)

12-Jun-06

Fleet Average	Idle (g/hr)	Low Speed (g/mile)	Cruise Speed (g/mile)
CO	731.7	259.9	349.0
HC*	37.8	8.0	17.4
NOx	3.1	20.4	19.9
PM-10**	0.11	0.05	0.05

Yellowstone Snowcoach Categories	Number in Commercial Fleet***	2005	2006
Type 1 Diesels	1	NPS Van	NPS Bus
Type 2 Old Bombardiers - 5.7L V-8 Carbureted	27	Xanterra 709	AG Kitty
Type 3 Retrofitted Bombardiers - 5.3L V-8 Fuel-injected	0	Alpen Guides	AG Cygnet
Type 4 Dodge 5.2L V-8 Fuel-injected	6	-	YEXP R250 & R350
Type 5 GMC 5.7L V-8 Fuel-injected	7	Xanterra 163-66	-
Type 6 Ford 6.8L V-10 Fuel-injected	4	-	BBC, YSCT & 3BL
Type 7 GMC 8.1L V-8 Fuel-injected	0	Xanterra 419	-
Type 8 GMC 6.0L V-8 Fuel-injected	3	Xanterra 416	-
Total (all types)	48		

Note: *HC emissions for Type 1 from MOBILE6 HDDV5. HC emissions were not measured for the NPS diesel van and bus sampled.

**PM-10 emissions for Type 2-8 from MOBILE6 LDGT4. PM emissions were not measured for any gasoline snowcoaches.

***Snowcoaches authorized to operate in Yellowstone, 2005-06 winter.

Weighting assumes all vehicles in the fleet are operated with equal frequency/time period.

Source: *In-use Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park*
 Bishop, Burgard, Dalton, and Stedman, University of Denver, January 2006
Potable Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park
 Bishop, Stadtmuller, and Stedman, University of Denver, May 2006

APPENDIX C
Snowcoach BAT Emissions Summary - Yellowstone National Park
Lower-emitting Snowcoach Averages for Modeling Purposes

6-Jul-06

NON-DIESEL SNOWCOACH BAT

Pollutant	Idle (g/hr)	Low Speed (g/mile)	Cruise Speed
CO	45.0	17.4	40.4
HC	12.3	1.6	1.0
NOx	2.0	6.7	9.8
PM-10*	0.11	0.05	0.04

DIESEL SNOWCOACH BAT

Pollutant	Idle (g/hr)	Low Speed (g/mile)	Cruise Speed
CO	19.3	16.5	6.0
HC**	6.3	1.4	0.7
NOx	50.4	46.3	38.5
PM-10	0.18	0.25	0.20

WEIGHTED AVERAGE SNOWCOACH BAT FOR MODELING

Pollutant	Idle (g/hr)	Low Speed (g/mile)	Cruise Speed
CO	43.7	17.4	38.7
HC	12.0	1.6	1.0
NOx	4.4	8.6	11.2
PM-10	0.11	0.06	0.05

Note: Proposed BAT emissions are determined by averaging a cleaner subset of snowcoaches tested in 2005 and 2006.

(Refer to attached table showing vehicles selected.)

Weighted average of non-diesel and diesel snowcoach emissions based on vehicle types in the current fleet.

*PM-10 emissions for non-diesel snowcoaches from MOBILE6 LDGT4.

**HC emissions for diesel snowcoaches from MOBILE6 HDDV5.

APPENDIX C
Snowcoach BAT Emissions - Yellowstone National Park
Lower-emitting Snowcoach Averages for Modeling Purposes

13-Jul-06

NON-DIESEL SNOWCOACHES

Test Year	CO	Idle (g/hr)	Low Speed	Cruise Speed (g/mile)
2005	Xanterra 416	17.3	5.8	94.0
	Xanterra 419	57.6	35.0	5.8
	Alpen Guides	13.3	7.5	4.9
2006	BBC Vanterra	0.0	8.8	47.0
	BBC Van	0.0	0.1	67.0
	YEXP R250	158.4	47.0	84.0
	YEXP R350	140.4	41.0	44.0
	AG Cygnet	9.4	7.8	4.9
	3BL Van5	8.6	3.8	12.0
	Average	45.0	17.4	40.4
HC				
2005	Xanterra 416	4.0	0.9	0.8
	Xanterra 419	15.1	3.3	0.4
	Alpen Guides	4.7	1.4	0.8
2006	BBC Vanterra	1.1	0.5	0.9
	BBC Van	1.1	0.7	1.4
	YEXP R250	9.7	1.8	1.8
	YEXP R350	72.0	4.3	2.3
	AG Cygnet	1.4	0.6	0.4
	3BL Van5	1.4	0.7	0.3
	Average	12.3	1.6	1.0
NOx				
2005	Xanterra 416	1.4	21.0	27.0
	Xanterra 419	0.3	10.0	16.0
	Alpen Guides	0.1	1.4	1.4
2006	BBC Vanterra	0.7	0.1	0.1
	BBC Van	0.4	0.0	0.3
	YEXP R250	14.4	14.0	23.0
	YEXP R350	1.1	8.6	16.0
	AG Cygnet	0.0	1.4	2.9
	3BL Van5	0.0	3.5	1.2
	Average	2.0	6.7	9.8

DIESEL SNOWCOACHES*

Test Year	CO	Idle (g/hr)	Low Speed	Cruise Speed (g/mile)
2005	NPS Van	24.5	8.9	6.2
2006	NPS Bus	14.0	24.0	5.7
	Average	19.3	16.5	6.0
NOx				
2005	NPS Van	57.6	42.0	47.0
2006	NPS Bus	43.2	50.5	30.0
	Average	50.4	46.3	38.5
PM-10				
2005	NPS Van	0.25	0.10	0.10
2006	NPS Bus	0.11	0.40	0.30
	Average	0.18	0.25	0.20

Note: Proposed BAT emissions are determined by averaging a cleaner subset of snowcoaches tested in 2005 and 2006.

*Since only two diesel snowcoaches were tested in 2005 and 2006, diesel BAT is determined based on these vehicles.

Source: *In-use Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park*
 Bishop, Burgard, Dalton, and Stedman, University of Denver, January 2006
Potable Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park
 Bishop, Stadtmuller, and Stedman, University of Denver, May 2006

APPENDIX C
Yellowstone National Park Snowcoach Emissions
CO

Test Year		Idle (g/hr)	Low Speed	Cruise Speed (g/mile)	12-Jun-06 Type
2005	NPS Van	24.5	8.9	6.2	1
	Xanterra 163	61.2	88.0	660.0	5
	Xanterra 164	104.4	64.0	490.0	5
	Xanterra 165	540.0	65.0	330.0	5
	Xanterra 166	468.0	360.0	510.0	5
	Xanterra 416	17.3	5.8	94.0	8
	Xanterra 419	57.6	35.0	5.8	7
	Xanterra 709	936.0	580.0	580.0	2
	Alpen Guides	13.3	7.5	4.9	3
2006	NPS Bus	14.0	24.0	5.7	1
	BBC Vanterra	0.0	8.8	47.0	6
	BBC Van	0.0	0.1	67.0	6
	YEXP R250	158.4	47.0	84.0	4
	YEXP R350	140.4	41.0	44.0	4
	AG Cygnet	9.4	7.8	4.9	3
	YSCT Van	3.6	9.3	330.0	6
	3BL Van2	18.7	100.0	270.0	6
	3BL Van5	8.6	3.8	12.0	6
	AG Kitty	1440.0	240.0	310.0	2
	Average/Mean (unweighted)	211.3	89.3	202.9	

Test Year		Idle (mg/s)
2005	NPS Van	6.8
	Xanterra 163	17.0
	Xanterra 164	29.0
	Xanterra 165	150.0
	Xanterra 166	130.0
	Xanterra 416	4.8
	Xanterra 419	16.0
	Xanterra 709	260.0
	Alpen Guides	3.7
2006	NPS Bus	3.9
	BBC Vanterra	0.0
	BBC Van	0.0
	YEXP R250	44.0
	YEXP R350	39.0
	AG Cygnet	2.6
	YSCT Van	1.0
	3BL Van2	5.2
	3BL Van5	2.4
	AG Kitty	400.0

Source: *In-use Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park*

Bishop, Burgard, Dalton, and Stedman, University of Denver, January 2006

Potable Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park

Bishop, Stadtmuller, and Stedman, University of Denver, May 2006

APPENDIX C
Yellowstone National Park Snowcoach Emissions
HC

Test Year		Idle (g/hr)	Low Speed	Cruise Speed (g/mile)	12-Jun-06 Type
2005	NPS Van	na	na	na	1
	Xanterra 163	32.8	7.0	6.4	5
	Xanterra 164	24.1	5.9	4.9	5
	Xanterra 165	50.4	6.3	4.8	5
	Xanterra 166	54.0	22.0	30.0	5
	Xanterra 416	4.0	0.9	0.8	8
	Xanterra 419	15.1	3.3	0.4	7
	Xanterra 709	46.8	15.0	51.0	2
	Alpen Guides	4.7	1.4	0.8	3
2006	NPS Bus	na	na	na	1
	BBC Vanterra	1.1	0.5	0.9	6
	BBC Van	1.1	0.7	1.4	6
	YEXP R250	9.7	1.8	1.8	4
	YEXP R350	72.0	4.3	2.3	4
	AG Cygnet	1.4	0.6	0.4	3
	YSCT Van	0.4	0.3	1.5	6
	3BL Van2	2.2	1.7	2.5	6
	3BL Van5	1.4	0.7	0.3	6
	AG Kitty	46.8	6.1	3.3	2
Gasoline	Average/Mean (unweighted)	21.6	4.6	6.7	
Diesel	MOBILE6 HDDV5	6.3	1.4	0.7	

Test Year		Idle (mg/s)
2005	NPS Van	na
	Xanterra 163	9.1
	Xanterra 164	6.7
	Xanterra 165	14.0
	Xanterra 166	15.0
	Xanterra 416	1.1
	Xanterra 419	4.2
	Xanterra 709	13.0
	Alpen Guides	1.3
2006	NPS Bus	na
	BBC Vanterra	0.3
	BBC Van	0.3
	YEXP R250	2.7
	YEXP R350	20.0
	AG Cygnet	0.4
	YSCT Van	0.1
	3BL Van2	0.6
	3BL Van5	0.4
	AG Kitty	13.0

Source: *In-use Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park*
 Bishop, Burgard, Dalton, and Stedman, University of Denver, January 2006
Potable Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park
 Bishop, Stadtmuller, and Stedman, University of Denver, May 2006

APPENDIX C
Yellowstone National Park Snowcoach Emissions
NO_x

Test Year		Idle	Low Speed	Cruise Speed	12-Jun-06 Type	
		(g/hr)		(g/mile)		
2005	NPS Van		57.6	42.0	47.0	1
	Xanterra 163		9.4	38.0	24.0	5
	Xanterra 164		3.2	27.0	17.0	5
	Xanterra 165		2.9	21.0	15.0	5
	Xanterra 166		1.1	28.0	22.0	5
	Xanterra 416		1.4	21.0	27.0	8
	Xanterra 419		0.3	10.0	16.0	7
	Xanterra 709		1.1	9.4	7.0	2
	Alpen Guides		0.1	1.4	1.4	3
2006	NPS Bus		43.2	50.5	30.0	1
	BBC Vanterra		0.7	0.1	0.1	6
	BBC Van		0.4	0.0	0.3	6
	YEXP R250		14.4	14.0	23.0	4
	YEXP R350		1.1	8.6	16.0	4
	AG Cygnet		0.0	1.4	2.9	3
	YSCT Van		0.0	1.0	1.7	6
	3BL Van2		0.0	1.4	1.5	6
	3BL Van5		0.0	3.5	1.2	6
	AG Kitty		0.4	35.0	36.0	2
Average/Mean (unweighted)			7.2	16.5	15.2	

Test Year		Idle (mg/s)
2005	NPS Van	16.0
	Xanterra 163	2.6
	Xanterra 164	0.9
	Xanterra 165	0.8
	Xanterra 166	0.3
	Xanterra 416	0.4
	Xanterra 419	0.1
	Xanterra 709	0.3
	Alpen Guides	0.0
2006	NPS Bus	12.0
	BBC Vanterra	0.2
	BBC Van	0.1
	YEXP R250	4.0
	YEXP R350	0.3
	AG Cygnet	0.0
	YSCT Van	0.0
	3BL Van2	0.0
	3BL Van5	0.0
	AG Kitty	0.1

Source: *In-use Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park*

Bishop, Burgard, Dalton, and Stedman, University of Denver, January 2006

Potable Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park

Bishop, Stadtmuller, and Stedman, University of Denver, May 2006

APPENDIX C
Yellowstone National Park Snowcoach Emissions
PM-10

Test Year		Idle (g/hr)	Low Speed	Cruise Speed (g/mile)	12-Jun-06 Type
2005	NPS Van		0.25	0.10	1
2006	NPS Bus		0.11	0.40	1
Diesel	Average/Mean (unweighted)		0.18	0.25	0.20
Gasoline	MOBILE6 LDGT4		0.11	0.05	0.04
Test Year		Idle (mg/s)			
2005	NPS Van		0.07		
2006	NPS Bus		0.03		

Source: *In-use Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park*
 Bishop, Burgard, Dalton, and Stedman, University of Denver, January 2006
Potable Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park
 Bishop, Stadtmuller, and Stedman, University of Denver, May 2006

APPENDIX D
MOBILE6 EMISSIONS FILES

Summary of MOBILE6.2 Emission Factors for Modeling

Yellowstone National Park Winter Use Plan

3/30/2006

rev. 6/5/2006

for snowcoaches

rev. 7/28/2006

for labels

ONROAD VEHICLES (Alternative 6)

2008 Calendar Year

Onroad Vehicle Criteria Pollutant Emission Factors for Modeling

	CO			PM10			HC			NOx		
	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)
2008 Composite Emissions	188.7	30.3	19.3	0.62	0.15	0.15	14.6	1.93	1.22	28.2	7.33	5.86

3/29/2006

Onroad Vehicle HAPs Emission Factors

	Benzene			1-3 Butadiene			Formaldehyde			Acetaldehyde		
	Idle (mg/hr)	15 mph (mg/mi)	35 mph (mg/mi)	Idle (mg/hr)	15 mph (mg/mi)	35 mph (mg/mi)	Idle (mg/hr)	15 mph (mg/mi)	35 mph (mg/mi)	Idle (mg/hr)	15 mph (mg/mi)	35 mph (mg/mi)
2008 Composite Emissions	398.5	59.1	39.1	68.0	12.1	7.9	324.5	64.7	34.4	115.3	23.3	12.7

Onroad Vehicle HAPs Emissions as Percent of HC

	Benzene			1-3 Butadiene			Formaldehyde			Acetaldehyde		
	Idle	15 mph	35 mph	Idle	15 mph	35 mph	Idle	15 mph	35 mph	Idle	15 mph	35 mph
Percent of HC	2.73%	3.06%	3.20%	0.47%	0.63%	0.65%	2.22%	3.35%	2.82%	0.79%	1.21%	1.04%

Note:

Shaded values selected for determining HAPs emission inventories.

SNOWCOACHES

Gasoline PM10 (for all Alternatives)

1999 and Later Calendar Year

MOBILE6.2 for Gasoline Light-Duty Trucks4

	PM10		
	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)
LDGT4 Emissions	0.11	0.045	0.044

Diesel HC (for all Alternatives)

1999 and Later Calendar Year

MOBILE6.2 for Diesel Heavy-Duty Vehicles5

	HC		
	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)
HDDV5 Emissions	6.28	1.39	0.72

HAPs (for all Alternatives)

2005 Calendar Year

Snowcoach HAPs Emission Factors Based on MOBILE6.2 for Light- and Heavy-Duty Trucks

	Benzene			1-3 Butadiene			Formaldehyde			Acetaldehyde		
	Idle (mg/hr)	15 mph (mg/mi)	35 mph (mg/mi)	Idle (mg/hr)	15 mph (mg/mi)	35 mph (mg/mi)	Idle (mg/hr)	15 mph (mg/mi)	35 mph (mg/mi)	Idle (mg/hr)	15 mph (mg/mi)	35 mph (mg/mi)
2005 Composite Emissions	999.8	137.0	78.7	135.8	20.9	12.5	428.0	64.0	31.3	122.3	18.9	10.0

Snowcoach HAPs Emissions as Percent of HC

	Benzene			1-3 Butadiene			Formaldehyde			Acetaldehyde		
	Idle	15 mph	35 mph	Idle	15 mph	35 mph	Idle	15 mph	35 mph	Idle	15 mph	35 mph
Percent of HC	2.98%	3.55%	3.45%	0.41%	0.54%	0.55%	1.28%	1.66%	1.37%	0.36%	0.49%	0.44%

Note:

Shaded values selected for determining HAPs emission inventories.

Snowcoach HC Emissions Estimated by

MOBILE6.2

	HC		
	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)
2005 Composite	33.5	3.86	2.28

*
* This input file was updated on 3/07/2006
*
MOBILE6 INPUT FILE :

* 2008, January 1
* 2.5, 15 and 35 mph scenario runs
* PM10
* No I/M programs
* HC emissions as VOCs
* Winter temps
* High Altitude
* Conventional gasoline West
* Diesel fuel sulfur 15 ppm
* VMT fractions: 34% LDT4 / 11% CLASS 2b HDV / 11% CLASS 3 HDV / 11% CLASS 4 HDV / 33% BUS

POLLUTANTS : HC CO NOX
PARTICULATES :

RUN DATA

EXPAND EXHAUST :
IDLE PM EMISSIONS :

SCENARIO REC : Yellowstone Winter Commercial Mix 2.5mph
PARTICULATE EF : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE : 10.0
CALENDAR YEAR : 2008
MIN/MAX TEMP : 0. 30.
ALTITUDE : 2
VMT FRACTIONS :
0.0 0.0 0.0 0.0 0.34 0.11 0.11 0.11
0.0 0.0 0.0 0.0 0.0 0.0 0.33 0.0
AVERAGE SPEED : 2.5 Arterial
FUEL PROGRAM : 3
DIESEL SULFUR : 15.00
FUEL RVP : 13.5

END OF RUN

SCENARIO REC : Yellowstone Winter Commercial Mix 15mph
PARTICULATE EF : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE : 10.0
CALENDAR YEAR : 2008
MIN/MAX TEMP : 0. 30.
ALTITUDE : 2
VMT FRACTIONS :
0.0 0.0 0.0 0.0 0.34 0.11 0.11 0.11
0.0 0.0 0.0 0.0 0.0 0.0 0.33 0.0
AVERAGE SPEED : 15 Arterial
FUEL PROGRAM : 3
DIESEL SULFUR : 15.00
FUEL RVP : 13.5

END OF RUN

SCENARIO REC : Yellowstone Winter Commercial Mix 35mph
PARTICULATE EF : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE : 10.0
CALENDAR YEAR : 2008
MIN/MAX TEMP : 0. 30.
ALTITUDE : 2
VMT FRACTIONS :
0.0 0.0 0.0 0.0 0.0 0.34 0.11 0.11 0.11
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.33 0.0
AVERAGE SPEED : 35 Arterial
FUEL PROGRAM : 3
DIESEL SULFUR : 15.00
FUEL RVP : 13.5

END OF RUN

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
VMT Distribution:	0.0000	0.0000	0.3351		0.1270	0.0000	0.0049	0.5330	0.0000	1.0000

Composite Emission Factors (g/mi):										
Lead:	0.0000	0.0000	0.0000	0.0000	0.0000	-----	-----	-----	0.0000	0.0000
GASPM:	0.0042	0.0000	0.0048	0.0048	0.0543	-----	-----	-----	0.0205	0.0085
ECARBON:	-----	-----	-----	-----	-----	0.0000	0.0339	0.1252	-----	0.0669
OCARBON:	-----	-----	-----	-----	-----	0.0000	0.0488	0.1031	-----	0.0552
SO4:	0.0000	0.0000	0.0006	0.0006	0.0011	0.0000	0.0003	0.0012	0.0000	0.0010
Total Exhaust PM:	0.0042	0.0000	0.0055	0.0055	0.0554	0.0000	0.0830	0.2295	0.0205	0.1316
Brake:	0.0000	0.0000	0.0125	0.0125	0.0125	0.0000	0.0125	0.0125	0.0000	0.0125
Tire:	0.0000	0.0000	0.0080	0.0080	0.0094	0.0000	0.0080	0.0118	0.0000	0.0102
Total PM:	0.0042	0.0000	0.0260	0.0260	0.0773	0.0000	0.1036	0.2538	0.0205	0.1543
SO2:	0.0000	0.0000	0.0114	0.0114	0.0167	0.0000	0.0056	0.0168	0.0000	0.0149
NH3:	0.0000	0.0000	0.0995	0.0995	0.0451	0.0000	0.0068	0.0270	0.0000	0.0535

 * MOBILE6.2.03 (24-Sep-2003) *
 * Input file: 2008-P10.IN (file 1, run 3). *

* #####
 * Yellowstone Winter Commercial Mix 35mph
 * File 1, Run 3, Scenario 1.
 * #####

Calendar Year: 2008
 Month: Jan.
 Gasoline Fuel Sulfur Content: 30. ppm
 Diesel Fuel Sulfur Content: 15. ppm
 Particle Size Cutoff: 10.00 Microns
 Reformulated Gas: No

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
VMT Distribution:	0.0000	0.0000	0.3351		0.1270	0.0000	0.0049	0.5330	0.0000	1.0000

Composite Emission Factors (g/mi):										
Lead:	0.0000	0.0000	0.0000	0.0000	0.0000	-----	-----	-----	0.0000	0.0000
GASPM:	0.0042	0.0000	0.0049	0.0049	0.0542	-----	-----	-----	0.0205	0.0085
ECARBON:	-----	-----	-----	-----	-----	0.0000	0.0339	0.1252	-----	0.0669
OCARBON:	-----	-----	-----	-----	-----	0.0000	0.0488	0.1031	-----	0.0552
SO4:	0.0000	0.0000	0.0005	0.0005	0.0015	0.0000	0.0003	0.0012	0.0000	0.0010
Total Exhaust PM:	0.0042	0.0000	0.0054	0.0054	0.0557	0.0000	0.0830	0.2295	0.0205	0.1316
Brake:	0.0000	0.0000	0.0125	0.0125	0.0125	0.0000	0.0125	0.0125	0.0000	0.0125
Tire:	0.0000	0.0000	0.0080	0.0080	0.0094	0.0000	0.0080	0.0118	0.0000	0.0102
Total PM:	0.0042	0.0000	0.0260	0.0260	0.0776	0.0000	0.1036	0.2538	0.0205	0.1544
SO2:	0.0000	0.0000	0.0114	0.0114	0.0166	0.0000	0.0056	0.0168	0.0000	0.0149
NH3:	0.0000	0.0000	0.0995	0.0995	0.0451	0.0000	0.0068	0.0270	0.0000	0.0535

```
*****
* MOBILE6.2.03(24-Sep-2003)
* Input file: 2008-P10.IN (file 1, run 1).
*****
```

```
* #####
* Yellowstone Winter Commercial Mix 2.5mph
* File 1, Run 1, Scenario 1.
* #####
```

- * Reading PM Gas Carbon ZML Levels
- * from the external data file PMGZML.CSV

```
* Reading PM Gas Carbon DR1 Levels
* from the external data file PMGDR1.CSV
```

```
* Reading PM Gas Carbon DR2 Levels
* from the external data file PMGDR2.CSV
```

```
* Reading PM Diesel Zero Mile Levels
* from the external data file PMDZML.CSV
```

```
* Reading the First PM Deterioration Rates
* from the external data file PMDDR1.CSV
```

```
* Reading the Second PM Deterioration Rates
* from the external data file PMDDR2.CSV
```

M615 Comment:

User supplied VMT mix.

M583 Warning:

The user supplied arterial average speed of 2.5 will be used for all hours of the day. 100% of VMT has been assigned to the arterial/collector roadway type for all hours of the day and all vehicle types.

M616 Comment:

User has supplied post-1999 sulfur levels.

M 48 Warning:

```
there are no sales for vehicle class HDGV8b
```

* Reading Ammonia (NH3) Basic Emission Rates
* from the external data file PMNH3BER.D

* Reading Ammonia (NH3) Sulfur Deterioration Rates
* from the external data file PMNH3SDR.D

Calendar Year:	2008
Month:	Jan.
Altitude:	High
Minimum Temperature:	0.0 (F)
Maximum Temperature:	30.0 (F)
Absolute Humidity:	75. grains/lb
Nominal Fuel RVP:	13.5 psi
Weathered RVP:	13.5 psi
Fuel Sulfur Content:	30. ppm

Exhaust I/M Program: No

Evap I/M Program: No
ATP Program: No
Reformulated Gas: No

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
VTM Distribution:	0.0000	0.0000	0.3351		0.1270	0.0000	0.0049	0.5330	0.0000	1.0000

Composite Emission Factors (g/mi):										
Composite VOC :	0.000	0.000	9.746	9.746	12.033	0.000	1.301	1.961	0.00	5.846
Composite CO :	0.00	0.00	93.89	93.89	228.16	0.000	3.028	28.204	0.00	75.493
Composite NOX :	0.000	0.000	3.648	3.648	2.091	0.000	1.554	18.377	0.00	11.290

Exhaust emissions (g/mi):										
VOC Start:	0.000	0.000	1.222	1.222		0.000	0.178		0.000	
VOC Running:	0.000	0.000	3.888	3.888		0.000	1.123		0.000	
VOC Total Exhaust:	0.000	0.000	5.110	5.110	7.504	0.000	1.301	1.961	0.00	3.717
CO Start:	0.00	0.00	20.32	0.00		0.000	0.413		0.000	
CO Running:	0.00	0.00	73.56	0.00		0.000	2.615		0.000	
CO Total Exhaust:	0.00	0.00	93.89	0.00	228.16	0.000	3.028	28.204	0.00	75.493
NOx Start:	0.000	0.000	0.363	0.000		0.000	0.033		0.000	
NOx Running:	0.000	0.000	3.285	0.000		0.000	1.521		0.000	
NOx Total Exhaust:	0.000	0.000	3.648	0.000	2.091	0.000	1.554	18.377	0.00	11.290

```
*****
* MOBILE6.2.03(24-Sep-2003) *
* Input file: 2008-Pl0.IN (file 1, run 2). *
*****
```

```
* #####
* Yellowstone Winter Commercial Mix 15mph
* File 1, Run 2, Scenario 1.
* #####
```

```
* Reading PM Gas Carbon ZML Levels
* from the external data file PMGZML.CSV
```

- * Reading PM Gas Carbon DR1 Levels
- * from the external data file PMGDR1.CSV

```
* Reading PM Gas Carbon DR2 Levels
* from the external data file PMGDR2.CSV
```

```
* Reading PM Diesel Zero Mile Levels
* from the external data file PMDZML.CSV
```

```
* Reading the First PM Deterioration Rates
* from the external data file PMDDR1.CSV
```

```
* Reading the Second PM Deterioration Rates
* from the external data file PMDDR2.CSV
```

M615 Comment:

User supplied VMT mix.

* Reading the First PM Deterioration Rates
 * from the external data file PMDDR1.CSV

* Reading the Second PM Deterioration Rates
 * from the external data file PMDDR2.CSV

M615 Comment:

User supplied VMT mix.

M583 Warning:

The user supplied arterial average speed of 35.0
 will be used for all hours of the day. 100% of VMT
 has been assigned to the arterial/collector roadway
 type for all hours of the day and all vehicle types.

M616 Comment:

User has supplied post-1999 sulfur levels.

M 48 Warning:

there are no sales for vehicle class HDGV8b

Calendar Year: 2008
 Month: Jan.
 Altitude: High
 Minimum Temperature: 0.0 (F)
 Maximum Temperature: 30.0 (F)
 Absolute Humidity: 75. grains/lb
 Nominal Fuel RVP: 13.5 psi
 Weathered RVP: 13.5 psi
 Fuel Sulfur Content: 30. ppm

Exhaust I/M Program: No
 Evap I/M Program: No
 ATP Program: No
 Reformulated Gas: No

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
VMT Distribution:	0.0000	0.0000	0.3351		0.1270	0.0000	0.0049	0.5330	0.0000	1.0000

Composite Emission Factors (g/mi):										
Composite VOC :	0.000	0.000	2.190	2.190	1.424	0.000	0.499	0.561	0.00	1.216
Composite CO :	0.00	0.00	36.01	36.01	36.08	0.000	0.867	4.897	0.00	19.265
Composite NOX :	0.000	0.000	1.972	1.972	2.798	0.000	0.793	9.081	0.00	5.860

*
* This input file was updated on 3/30/2006
*
MOBILE6 INPUT FILE :

* 2008, January 1
* 2.5, 15 and 35 mph scenario runs for HAPs (air toxics)
* AIR TOXICS run
* No I/M programs
* HC emissions as VOCs
* Winter temps
* High Altitude
* Conventional gasoline West (assume no RFG or oxy fuel)
* GAS AROMATIC%, GAS OLEFIN%, GAS BENZENE%, E200, and E300 based on M6 manual typical range (average)
* Diesel fuel sulfur 15 ppm
* VMT fractions: 34% LDT4 / 11% CLASS 2b HDV / 11% CLASS 3 HDV / 11% CLASS 4 HDV / 33% BUS

POLLUTANTS : HC
AIR TOXICS : BENZ BUTA FORM ACET

RUN DATA

EXPAND EXHAUST :

SCENARIO REC : Yellowstone Winter Commercial Mix 2.5mph
CALENDAR YEAR : 2008
MIN/MAX TEMP : 0. 30.
ALTITUDE : 2
GAS AROMATIC% : 20
GAS OLEFIN% : 25
GAS BENZENE% : 1.5
E200 : 45
E300 : 85
OXYGENATE : MTBE 0 0
: ETBE 0 0
: ETOH 0 0
: TAME 0 0
VMT FRACTIONS :
0.0 0.0 0.0 0.0 0.0 0.34 0.11 0.11 0.11
0.0 0.0 0.0 0.0 0.0 0.0 0.33 0.0
AVERAGE SPEED : 2.5 Arterial
FUEL PROGRAM : 3
DIESEL SULFUR : 15.00
FUEL RVP : 13.5

END OF RUN

SCENARIO REC : Yellowstone Winter Commercial Mix 15mph
CALENDAR YEAR : 2008
MIN/MAX TEMP : 0. 30.
ALTITUDE : 2
GAS AROMATIC% : 20
GAS OLEFIN% : 25
GAS BENZENE% : 1.5
E200 : 45

E300 : 85
OXYGENATE : MTBE 0 0
: ETBE 0 0
: ETOH 0 0
: TAME 0 0
VMT FRACTIONS :
0.0 0.0 0.0 0.0 0.34 0.11 0.11 0.11
0.0 0.0 0.0 0.0 0.0 0.0 0.33 0.0
AVERAGE SPEED : 15 Arterial
FUEL PROGRAM : 3
DIESEL SULFUR : 15.00
FUEL RVP : 13.5

END OF RUN

SCENARIO REC : Yellowstone Winter Commercial Mix 35mph
CALENDAR YEAR : 2008
MIN/MAX TEMP : 0. 30.
ALTITUDE : 2
GAS AROMATIC% : 20
GAS OLEFIN% : 25
GAS BENZENE% : 1.5
E200 : 45
E300 : 85
OXYGENATE : MTBE 0 0
: ETBE 0 0
: ETOH 0 0
: TAME 0 0
VMT FRACTIONS :
0.0 0.0 0.0 0.0 0.34 0.11 0.11 0.11
0.0 0.0 0.0 0.0 0.0 0.0 0.33 0.0
AVERAGE SPEED : 35 Arterial
FUEL PROGRAM : 3
DIESEL SULFUR : 15.00
FUEL RVP : 13.5

END OF RUN

* #
 * Yellowstone Winter Commercial Mix 2.5mph
 * File 1, Run 1, Scenario 1.
 * #

Calendar Year: 2008
 Month: Jan.
 Market Weighted Oxygen Level: 0.000 wt%
 Gasoline Fuel Sulfur Content: 30. ppm
 Maximum Temperature: 30.0 F
 Minimum Temperature: 0.0 F
 Weathered RVP: 13.5 psi
 E200: 45.00 %
 E300: 85.00 %
 Aromatics: 20.00 vol%
 Olefins: 25.00 vol%
 Benzene: 1.50 vol%
 MTBE: 0.00 vol% (market fraction: 0.000)
 ETBE: 0.00 vol% (market fraction: 0.000)
 Ethanol: 0.00 vol% (market fraction: 0.000)
 TAME: 0.00 vol% (market fraction: 0.000)

Vehicle Type: GVWR:	LDGV	LDGT12 <6000	LDGT34 >6000	LDGT (All)	HDGV	LDDV	LDDT	HDDV	MC	All Veh
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
VMT Distribution:	0.0000	0.0000	0.3351		0.1270	0.0000	0.0049	0.5330	0.0000	1.0000

Exhaust Emission Factors (mg/mi):										
Benzene:	0.00	0.00	257.45	257.45	298.22	0.00	26.15	21.59	0.00	135.791
1,3 Butadiene:	0.00	0.00	46.56	46.56	38.36	0.00	11.77	12.54	0.00	27.219
Formaldehyde:	0.00	0.00	59.50	59.50	188.01	0.00	50.46	160.79	0.00	129.763
Acetaldehyde:	0.00	0.00	25.64	25.64	45.95	0.00	16.08	59.22	0.00	46.069

Evaporative Emission Factors (mg/mi):										
Benzene Hot Soak :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Benzene Diurnal :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Benzene Running :	0.00	0.00	48.49	48.49	45.80	0.00	0.00	0.00	0.00	22.067
Benzene Resting :	0.00	0.00	1.33	1.33	1.34	0.00	0.00	0.00	0.00	0.616
Benzene Refueling:	0.00	0.00	1.69	1.69	3.07	0.00	0.00	0.00	0.00	0.957
Benzene Total Evp:	0.00	0.00	51.51	51.51	50.20	0.00	0.00	0.00	0.00	23.640

Exhaust + Evaporative Emission Factors (mg/mi):										
Benzene Exh + Evp:	0.00	0.00	308.97	308.97	348.42	0.00	26.15	21.59	0.00	159.431

* #
 * Yellowstone Winter Commercial Mix 15mph
 * File 1, Run 2, Scenario 1.
 * #

Calendar Year: 2008
 Month: Jan.
 Market Weighted Oxygen Level: 0.000 wt%
 Gasoline Fuel Sulfur Content: 30. ppm
 Maximum Temperature: 30.0 F

Minimum Temperature: 0.0 F
 Weathered RVP: 13.5 psi
 E200: 45.00 %
 E300: 85.00 %
 Aromatics: 20.00 vol%
 Olefins: 25.00 vol%
 Benzene: 1.50 vol%
 MTBE: 0.00 vol% (market fraction: 0.000)
 ETBE: 0.00 vol% (market fraction: 0.000)
 Ethanol: 0.00 vol% (market fraction: 0.000)
 TAME: 0.00 vol% (market fraction: 0.000)

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
VTM Distribution:	0.0000	0.0000	0.3351		0.1270	0.0000	0.0049	0.5330	0.0000	1.0000

Exhaust Emission Factors (mg/mi):										
Benzene:	0.00	0.00	108.36	108.36	106.37	0.00	16.07	11.95	0.00	56.272
1,3 Butadiene:	0.00	0.00	19.89	19.89	13.68	0.00	7.23	6.94	0.00	12.138
Formaldehyde:	0.00	0.00	25.51	25.51	67.06	0.00	31.01	89.02	0.00	64.663
Acetaldehyde:	0.00	0.00	10.92	10.92	16.39	0.00	9.88	32.78	0.00	23.264

Evaporative Emission Factors (mg/mi):										
Benzene Hot Soak :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Benzene Diurnal :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Benzene Running :	0.00	0.00	2.85	2.85	2.69	0.00	0.00	0.00	0.00	1.295
Benzene Resting :	0.00	0.00	1.33	1.33	1.34	0.00	0.00	0.00	0.00	0.616
Benzene Refueling:	0.00	0.00	1.69	1.69	3.07	0.00	0.00	0.00	0.00	0.957
Benzene Total Evp:	0.00	0.00	5.87	5.87	7.09	0.00	0.00	0.00	0.00	2.868

Exhaust + Evaporative Emission Factors (mg/mi):										
Benzene Exh + Evp:	0.00	0.00	114.23	114.23	113.46	0.00	16.07	11.95	0.00	59.140

* #
 * Yellowstone Winter Commercial Mix 35mph
 * File 1, Run 3, Scenario 1.
 * #

Calendar Year: 2008
 Month: Jan.
 Market Weighted Oxygen Level: 0.000 wt%
 Gasoline Fuel Sulfur Content: 30. ppm
 Maximum Temperature: 30.0 F
 Minimum Temperature: 0.0 F
 Weathered RVP: 13.5 psi
 E200: 45.00 %
 E300: 85.00 %
 Aromatics: 20.00 vol%
 Olefins: 25.00 vol%
 Benzene: 1.50 vol%
 MTBE: 0.00 vol% (market fraction: 0.000)
 ETBE: 0.00 vol% (market fraction: 0.000)
 Ethanol: 0.00 vol% (market fraction: 0.000)
 TAME: 0.00 vol% (market fraction: 0.000)

Vehicle Type: GVWR:	LDGV	LDGT12 <6000	LDGT34 >6000	LDGT (All)	HDGV	LDDV	LDDT	HDDV	MC	All Veh
----- VMT Distribution:	0.0000	0.0000	0.3351	-----	0.1270	0.0000	0.0049	0.5330	0.0000	1.0000

Exhaust Emission Factors (mg/mi):										
Benzene:	0.00	0.00	87.19	87.19	35.05	0.00	10.03	6.18	0.00	37.013
1,3 Butadiene:	0.00	0.00	16.14	16.14	4.51	0.00	4.51	3.59	0.00	7.916
Formaldehyde:	0.00	0.00	20.75	20.75	22.10	0.00	19.36	46.01	0.00	34.375
Acetaldehyde:	0.00	0.00	8.85	8.85	5.40	0.00	6.17	16.94	0.00	12.713

Evaporative Emission Factors (mg/mi):										
Benzene Hot Soak :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Benzene Diurnal :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Benzene Running :	0.00	0.00	1.22	1.22	1.15	0.00	0.00	0.00	0.00	0.555
Benzene Resting :	0.00	0.00	1.33	1.33	1.34	0.00	0.00	0.00	0.00	0.616
Benzene Refueling:	0.00	0.00	1.69	1.69	3.07	0.00	0.00	0.00	0.00	0.957
Benzene Total Evp:	0.00	0.00	4.24	4.24	5.55	0.00	0.00	0.00	0.00	2.128

Exhaust + Evaporative Emission Factors (mg/mi):										
Benzene Exh + Evp:	0.00	0.00	91.44	91.44	40.61	0.00	10.03	6.18	0.00	39.141

M615 Comment:

M583 Warning:

M616 Comment:

M 48 Warning:

Calendar Year: 2008

Month: Jan

Altitude: High

Minimum Temperature: 0.0 (F)

Maximum Temperature: 30.0 (F)

Absolute Humidity: 75. grains/lb

Nominal Fuel RVP: 13.5 psi

Weathered RVP: 13.5 psi

Fuel Sulfur Content: 30. ppm

Exhaust I/M Program: No

Evap I/M Program: No

ATP Program: No

Reformulated Gas: NA (See Air Toxics Output)

Ether Blend Market Share: 0.000

Alcohol Blend Market Share: 0.000

Ether Blend Oxygen Content: 0.000

Alcohol Blend Oxygen Content: 0.000

Alcohol Blend RVP Waiver: No

Composite Emission Factors (g/mi):

Composite VOC :	0.000	0.000	2.746	2.746	3.355	0.000	0.799	1.086	0.00	1.929
-----------------	-------	-------	-------	-------	-------	-------	-------	-------	------	-------

```
*****
* MOBILE6.2.03(24-Sep-2003) *
* Input file: 2008-HAP.IN (file 1, run 3). *
*****
```

M615 Comment:

Page: 15

M583 Warning:

The user supplied arterial average speed of 35.0
will be used for all hours of the day. 100% of VMT
has been assigned to the arterial/collector roadway
type for all hours of the day and all vehicle types.

M616 Comment:

User has supplied post-1999 sulfur levels.

M 48 Warning:

there are no sales for vehicle class HDGV8b

Calendar Year: 2008
Month: Jan.
Altitude: High
Minimum Temperature: 0.0 (F)
Maximum Temperature: 30.0 (F)
Absolute Humidity: 75. grains/lb
Nominal Fuel RVP: 13.5 psi
Weathered RVP: 13.5 psi
Fuel Sulfur Content: 30. ppm

Exhaust I/M Program: No
Evap I/M Program: No
ATP Program: No
Reformulated Gas: NA (See Air Toxics Output)

Ether Blend Market Share: 0.000 Alcohol Blend Market Share: 0.000
Ether Blend Oxygen Content: 0.000 Alcohol Blend Oxygen Content: 0.000
Alcohol Blend RVP Waiver: No

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
VMT Distribution:	0.0000	0.0000	0.3351		0.1270	0.0000	0.0049	0.5330	0.0000	1.0000

Composite Emission Factors (g/mi):										
Composite VOC :	0.000	0.000	2.190	2.190	1.424	0.000	0.499	0.561	0.00	1.216

```

*
* This input file was updated on 3/30/2006
*
MOBILE6 INPUT FILE :

* 2005, January 1 - For modeling current snowcoach HAPs
* 2.5, 15 and 35 mph scenario runs for HAPs (air toxics)
* AIR TOXICS run
* No I/M programs
* HC emissions as VOCs
* Winter temps
* High Altitude
* Conventional gasoline West (assume no RFG or oxy fuel)
* GAS AROMATIC%, GAS OLEFIN%, GAS BENZENE%, E200, and E300 based on M6 manual typical range (average)
* Diesel fuel sulfur 15 ppm
* Diesel fraction 5% for all 14 classes/25 years
* VMT fractions: 50% LDT4 / 17% CLASS 2b HDV / 17% CLASS 3 HDV / 16% CLASS 4 HDV

```

```

POLLUTANTS      : HC
AIR TOXICS      : BENZ BUTA FORM ACET

```

RUN DATA

```

EXPAND EXHAUST  :

```

```

SCENARIO REC    : Yellowstone Winter Commercial Mix 2.5mph
CALENDAR YEAR   : 2005
MIN/MAX TEMP    : 0. 30.
ALTITUDE        : 2
GAS AROMATIC%   : 20
GAS OLEFIN%     : 25
GAS BENZENE%    : 1.5
E200            : 45
E300            : 85
OXYGENATE       : MTBE  0    0
                 : ETBE  0    0
                 : ETOH  0    0
                 : TAME  0    0
DIESEL FRACTIONS :
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05

```


[illegible]

```

VMT FRACTIONS      :
0.0 0.0 0.0 0.0 0.0 0.50 0.17 0.17 0.16
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
AVERAGE SPEED      : 2.5 Arterial
FUEL PROGRAM         : 3
DIESEL SULFUR        : 15.00
FUEL RVP             : 13.5

```

END OF RUN

SCENARIO REC	:	Yellowstone Winter Commercial Mix 15mph		
CALENDAR YEAR	:	2005		
MIN/MAX TEMP	:	0. 30.		
ALTITUDE	:	2		
GAS AROMATIC%	:	20		
GAS OLEFIN%	:	25		
GAS BENZENE%	:	1.5		
E200	:	45		
E300	:	85		
OXYGENATE	:	MTBE	0	0
	:	ETBE	0	0
	:	ETOH	0	0
	:	TAME	0	0

[illegible]

0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05
0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05

VMT FRACTIONS :
0.0 0.0 0.0 0.0 0.50 0.17 0.17 0.16
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
AVERAGE SPEED : 35 Arterial
FUEL PROGRAM : 3
DIESEL SULFUR : 15.00
FUEL RVP : 13.5

END OF RUN

Calendar Year:	2005	
Month:	Jan.	
Market Weighted Oxygen Level:	0.000	wt%
Gasoline Fuel Sulfur Content:	160.	ppm
Maximum Temperature:	30.0	F
Minimum Temperature:	0.0	F
Weathered RVP:	13.5	psi
E200:	45.00	%
E300:	85.00	%
Aromatics:	20.00	vol%
Olefins:	25.00	vol%
Benzene:	1.50	vol%
MTBE:	0.00	vol% (market fraction: 0.000)
ETBE:	0.00	vol% (market fraction: 0.000)
Ethanol:	0.00	vol% (market fraction: 0.000)
TAME:	0.00	vol% (market fraction: 0.000)

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Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
VTM Distribution:	0.0000	0.0000	0.4714		0.4674	0.0000	0.0286	0.0326	0.0000	1.0000

Exhaust Emission Factors (mg/mi):										
Benzene:	0.00	0.00	109.71	109.71	44.66	0.00	12.52	6.19	0.00	73.150
1,3 Butadiene:	0.00	0.00	19.75	19.75	6.14	0.00	5.63	3.60	0.00	12.457
Formaldehyde:	0.00	0.00	31.72	31.72	29.92	0.00	24.17	46.13	0.00	31.133
Acetaldehyde:	0.00	0.00	12.42	12.42	7.14	0.00	7.70	16.99	0.00	9.970

Evaporative Emission Factors (mg/mi):										
Benzene Hot Soak :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Benzene Diurnal :	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Benzene Running :	0.00	0.00	1.44	1.44	1.35	0.00	0.00	0.00	0.00	1.309
Benzene Resting :	0.00	0.00	1.38	1.38	1.22	0.00	0.00	0.00	0.00	1.222
Benzene Refueling:	0.00	0.00	2.45	2.45	4.02	0.00	0.00	0.00	0.00	3.031
Benzene Total Evp:	0.00	0.00	5.27	5.27	6.59	0.00	0.00	0.00	0.00	5.562

Exhaust + Evaporative Emission Factors (mg/mi):										
Benzene Exh + Evp:	0.00	0.00	114.98	114.98	51.25	0.00	12.52	6.19	0.00	78.712

 * MOBILE6.2.03 (24-Sep-2003) *
 * Input file: SC-HAP.IN (file 1, run 1). *

* #####
 * Yellowstone Winter Commercial Mix 2.5mph
 * File 1, Run 1, Scenario 1.
 * #####

M614 Comment:

User supplied diesel sale fractions.

M615 Comment:

User supplied VMT mix.

M583 Warning:

The user supplied arterial average speed of 2.5
 will be used for all hours of the day. 100% of VMT
 has been assigned to the arterial/collector roadway
 type for all hours of the day and all vehicle types.

M616 Comment:

User has supplied post-1999 sulfur levels.

Calendar Year: 2005
 Month: Jan.
 Altitude: High
 Minimum Temperature: 0.0 (F)
 Maximum Temperature: 30.0 (F)
 Absolute Humidity: 75. grains/lb
 Nominal Fuel RVP: 13.5 psi
 Weathered RVP: 13.5 psi
 Fuel Sulfur Content: 160. ppm

 Exhaust I/M Program: No
 Evap I/M Program: No
 ATP Program: No
 Reformulated Gas: NA (See Air Toxics Output)

Ether Blend Market Share: 0.000 Alcohol Blend Market Share: 0.000
 Ether Blend Oxygen Content: 0.000 Alcohol Blend Oxygen Content: 0.000
 Alcohol Blend RVP Waiver: No

Vehicle Type: GVWR:	LDGV	LDGT12 <6000	LDGT34 >6000	LDGT (All)	HDGV	LDDV	LDDT	HDDV	MC	All Veh
VMT Distribution:	0.0000	0.0000	0.4714		0.4674	0.0000	0.0286	0.0326	0.0000	1.0000

Composite Emission Factors (g/mi):										
Composite VOC :	0.000	0.000	13.033	13.033	15.223	0.000	1.648	1.952	0.00	13.369

Exhaust emissions (g/mi):										
VOC Start:	0.000	0.000	1.652	1.652		0.000	0.211		0.000	
VOC Running:	0.000	0.000	5.882	5.882		0.000	1.437		0.000	
VOC Total Exhaust:	0.000	0.000	7.534	7.534	9.914	0.000	1.648	1.952	0.00	8.296

 * MOBILE6.2.03 (24-Sep-2003) *
 * Input file: SC-HAP.IN (file 1, run 2). *

M615 Comment:

User supplied VMT mix.

M583 Warning:

The user supplied arterial average speed of 35.0
will be used for all hours of the day. 100% of VMT
has been assigned to the arterial/collector roadway
type for all hours of the day and all vehicle types.

M616 Comment:

User has supplied post-1999 sulfur levels.

Calendar Year: 2005
Month: Jan.
Altitude: High
Minimum Temperature: 0.0 (F)
Maximum Temperature: 30.0 (F)
Absolute Humidity: 75. grains/lb
Nominal Fuel RVP: 13.5 psi
Weathered RVP: 13.5 psi
Fuel Sulfur Content: 160. ppm

Exhaust I/M Program: No
Evap I/M Program: No
ATP Program: No
Reformulated Gas: NA (See Air Toxics Output)

Ether Blend Market Share: 0.000 Alcohol Blend Market Share: 0.000
Ether Blend Oxygen Content: 0.000 Alcohol Blend Oxygen Content: 0.000
Alcohol Blend RVP Waiver: No

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
VMT Distribution:	0.0000	0.0000	0.4714		0.4674	0.0000	0.0286	0.0326	0.0000	1.0000

Composite Emission Factors (g/mi):										
Composite VOC :	0.000	0.000	2.972	2.972	1.805	0.000	0.622	0.559	0.00	2.281

*
* This input file was updated on 6/5/2006
*
MOBILE6 INPUT FILE :

* 1999, January 1 - For modeling gasoline snowcoach PM10
* 2.5, 15 and 35 mph scenario runs
* PM10 run
* No I/M programs
* HC emissions as VOCs
* Winter temps
* High Altitude
* Conventional gasoline West (assume no RFG or oxy fuel)

PARTICULATES :

RUN DATA

EXPAND LDT EFS :

SCENARIO REC : Yellowstone Winter 2.5mph
PARTICULATE EF : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE : 10.0
CALENDAR YEAR : 1999
MIN/MAX TEMP : 0. 30.
ALTITUDE : 2
AVERAGE SPEED : 2.5 Arterial
FUEL PROGRAM : 3
DIESEL SULFUR : 330.00
FUEL RVP : 13.5

END OF RUN

EXPAND LDT EFS :

SCENARIO REC : Yellowstone Winter 15mph
PARTICULATE EF : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE : 10.0
CALENDAR YEAR : 1999
MIN/MAX TEMP : 0. 30.
ALTITUDE : 2
AVERAGE SPEED : 15 Arterial
FUEL PROGRAM : 3
DIESEL SULFUR : 330.00
FUEL RVP : 13.5

END OF RUN

EXPAND LDT EFS :

SCENARIO REC : Yellowstone Winter 35mph
PARTICULATE EF : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE : 10.0
CALENDAR YEAR : 1999
MIN/MAX TEMP : 0. 30.
ALTITUDE : 2

AVERAGE SPEED : 35 Arterial
FUEL PROGRAM : 3
DIESEL SULFUR : 330.00
FUEL RVP : 13.5

END OF RUN

Calendar Year:	1999
Month:	Jan.
Gasoline Fuel Sulfur Content:	300. ppm
Diesel Fuel Sulfur Content:	330. ppm
Particle Size Cutoff:	10.00 Microns
Reformulated Gas:	No

Veh. Type:	LDGT1	LDGT2	LDGT3	LDGT4	LDDT12	LDDT34
	-----	-----	-----	-----	-----	-----
VMT Mix:	0.0621	0.2066	0.0630	0.0290	0.0005	0.0012

```
*****
* MOBILE6.2.03(24-Sep-2003) *
* Input file: SCG-P10.IN (file 1, run 2). *
*****
```


* #

Calendar Year: 1999
 Month: Jan.
 Gasoline Fuel Sulfur Content: 300. ppm
 Diesel Fuel Sulfur Content: 330. ppm
 Particle Size Cutoff: 10.00 Microns
 Reformulated Gas: No

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
VTM Distribution:	0.5138	0.2687	0.0919		0.0356	0.0015	0.0017	0.0804	0.0064	1.0000

Composite Emission Factors (g/mi):										
Lead:	0.0000	0.0000	0.0000	0.0000	0.0000	-----	-----	-----	0.0000	0.0000
GASPM:	0.0046	0.0060	0.0171	0.0088	0.0904	-----	-----	-----	0.0205	0.0089
ECARBON:	-----	-----	-----	-----	-----	0.2258	0.1179	0.3861	-----	0.0316
OCARBON:	-----	-----	-----	-----	-----	0.0637	0.1696	0.1900	-----	0.0157
SO4:	0.0044	0.0062	0.0064	0.0063	0.0077	0.0040	0.0060	0.0210	0.0009	0.0065
Total Exhaust PM:	0.0090	0.0122	0.0236	0.0151	0.0981	0.2935	0.2934	0.5972	0.0214	0.0626
Brake:	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
Tire:	0.0080	0.0080	0.0080	0.0080	0.0088	0.0080	0.0080	0.0261	0.0040	0.0095
Total PM:	0.0295	0.0327	0.0441	0.0356	0.1195	0.3140	0.3140	0.6358	0.0379	0.0847
SO2:	0.0689	0.0862	0.1148	0.0935	0.1784	0.0763	0.1143	0.3006	0.0329	0.1001
NH3:	0.0996	0.0959	0.0892	0.0942	0.0451	0.0068	0.0068	0.0270	0.0113	0.0890

Veh. Type:	LDGT1	LDGT2	LDGT3	LDGT4	LDDT12	LDDT34				
	-----	-----	-----	-----	-----	-----				
VTM Mix:	0.0621	0.2066	0.0630	0.0290	0.0005	0.0012				

Composite Emission Factors (g/mi):										
Lead:	0.0000	0.0000	0.0000	0.0000	-----	-----				
GASPM:	0.0060	0.0060	0.0171	0.0171	-----	-----				
ECARBON:	-----	-----	-----	-----	0.2155	0.0777				
OCARBON:	-----	-----	-----	-----	0.3101	0.1118				
SO4:	0.0062	0.0062	0.0064	0.0064	0.0050	0.0064				
Total Exhaust PM:	0.0122	0.0122	0.0236	0.0236	0.5305	0.1959				
Brake:	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125				
Tire:	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080				
Total PM:	0.0327	0.0327	0.0441	0.0441	0.5510	0.2165				
SO2:	0.0862	0.0862	0.1148	0.1148	0.0952	0.1221				
NH3:	0.0959	0.0959	0.0892	0.0892	0.0068	0.0068				

*
* This input file was updated on 6/5/2006
*
MOBILE6 INPUT FILE :

* 1999, January 1 - For modeling diesel snowcoach HC
* 2.5, 15 and 35 mph scenario runs
* HC run
* No I/M programs
* HC emissions as VOCs
* Winter temps
* High Altitude
* Conventional gasoline West (assume no RFG or oxy fuel)

POLLUTANTS : HC

RUN DATA

EXPAND HDDV EFS :

SCENARIO REC : Yellowstone Winter 2.5mph
CALENDAR YEAR : 1999
MIN/MAX TEMP : 0. 30.
ALTITUDE : 2
AVERAGE SPEED : 2.5 Arterial
FUEL PROGRAM : 3
FUEL RVP : 13.5

END OF RUN

EXPAND HDDV EFS :

SCENARIO REC : Yellowstone Winter 15mph
CALENDAR YEAR : 1999
MIN/MAX TEMP : 0. 30.
ALTITUDE : 2
AVERAGE SPEED : 15 Arterial
FUEL PROGRAM : 3
FUEL RVP : 13.5

END OF RUN

EXPAND HDDV EFS :

SCENARIO REC : Yellowstone Winter 35mph
CALENDAR YEAR : 1999
MIN/MAX TEMP : 0. 30.
ALTITUDE : 2
AVERAGE SPEED : 35 Arterial
FUEL PROGRAM : 3
FUEL RVP : 13.5

END OF RUN

 * MOBILE6.2.03 (24-Sep-2003) *
 * Input file: SCD-HC.IN (file 1, run 1). *

* #####

* Yellowstone Winter 2.5mph

* File 1, Run 1, Scenario 1.

* #####

M583 Warning:

The user supplied arterial average speed of 2.5
 will be used for all hours of the day. 100% of VMT
 has been assigned to the arterial/collector roadway
 type for all hours of the day and all vehicle types.

M616 Comment:

User has supplied post-1999 sulfur levels.

M 48 Warning:

there are no sales for vehicle class HDGV8b

Calendar Year: 1999
 Month: Jan.
 Altitude: High
 Minimum Temperature: 0.0 (F)
 Maximum Temperature: 30.0 (F)
 Absolute Humidity: 75. grains/lb
 Nominal Fuel RVP: 13.5 psi
 Weathered RVP: 13.5 psi
 Fuel Sulfur Content: 300. ppm

Exhaust I/M Program: No
 Evap I/M Program: No
 ATP Program: No
 Reformulated Gas: No

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
VMT Distribution:	0.5138	0.2687	0.0919		0.0356	0.0015	0.0017	0.0804	0.0064	1.0000

 Composite Emission Factors (g/mi):

Composite VOC :	11.89	12.97	18.94	14.49	24.41	2.19	3.68	5.56	9.91	12.722
-----------------	-------	-------	-------	-------	-------	------	------	------	------	--------

 Veh. Type: HDDV2B HDDV3 HDDV4 HDDV5 HDDV6 HDDV7 HDDV8A HDDV8B

VMT Mix:	0.0096	0.0028	0.0022	0.0009	0.0055	0.0084	0.0107	0.0382
----------	--------	--------	--------	--------	--------	--------	--------	--------

 Composite Emission Factors (g/mi):

Composite VOC :	1.99	2.32	2.58	2.51	3.87	4.92	5.67	7.22
-----------------	------	------	------	------	------	------	------	------

 * MOBILE6.2.03 (24-Sep-2003) *
 * Input file: SCD-HC.IN (file 1, run 2). *

* #####

* Yellowstone Winter 15mph

* File 1, Run 2, Scenario 1.

* #####

M583 Warning:

The user supplied arterial average speed of 15.0
will be used for all hours of the day. 100% of VMT
has been assigned to the arterial/collector roadway
type for all hours of the day and all vehicle types.

M616 Comment:

User has supplied post-1999 sulfur levels.

M 48 Warning:

there are no sales for vehicle class HDGV8b

Calendar Year: 1999
Month: Jan.
Altitude: High
Minimum Temperature: 0.0 (F)
Maximum Temperature: 30.0 (F)
Absolute Humidity: 75. grains/lb
Nominal Fuel RVP: 13.5 psi
Weathered RVP: 13.5 psi
Fuel Sulfur Content: 300. ppm

Exhaust I/M Program: No
Evap I/M Program: No
ATP Program: No
Reformulated Gas: No

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
VMT Distribution:	0.5138	0.2687	0.0919		0.0356	0.0015	0.0017	0.0804	0.0064	1.0000

Composite Emission Factors (g/mi):										
Composite VOC :	3.06	3.85	6.14	4.44	7.17	1.39	2.46	3.08	3.36	3.705

Veh. Type:	HDDV2B	HDDV3	HDDV4	HDDV5	HDDV6	HDDV7	HDDV8A	HDDV8B		
	-----	-----	-----	-----	-----	-----	-----	-----		
VMT Mix:	0.0096	0.0028	0.0022	0.0009	0.0055	0.0084	0.0107	0.0382		

Composite Emission Factors (g/mi):										
Composite VOC :	1.10	1.29	1.43	1.39	2.14	2.72	3.14	4.00		

* MOBILE6.2.03 (24-Sep-2003) *
* Input file: SCD-HC.IN (file 1, run 3). *

* #####

* Yellowstone Winter 35mph

* File 1, Run 3, Scenario 1.

* #####

M583 Warning:

The user supplied arterial average speed of 35.0
will be used for all hours of the day. 100% of VMT
has been assigned to the arterial/collector roadway
type for all hours of the day and all vehicle types.

M616 Comment:

User has supplied post-1999 sulfur levels.

M 48 Warning:

there are no sales for vehicle class HDGV8b

Calendar Year: 1999
 Month: Jan.
 Altitude: High
 Minimum Temperature: 0.0 (F)
 Maximum Temperature: 30.0 (F)
 Absolute Humidity: 75. grains/lb
 Nominal Fuel RVP: 13.5 psi
 Weathered RVP: 13.5 psi
 Fuel Sulfur Content: 300. ppm

Exhaust I/M Program: No
 Evap I/M Program: No
 ATP Program: No
 Reformulated Gas: No

Vehicle Type:	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
GVWR:		<6000	>6000	(All)						
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
VMT Distribution:	0.5138	0.2687	0.0919		0.0356	0.0015	0.0017	0.0804	0.0064	1.0000

Composite Emission Factors (g/mi):										
Composite VOC :	2.40	3.04	4.97	3.53	2.79	0.91	1.73	1.59	2.45	2.755

Veh. Type:	HDDV2B	HDDV3	HDDV4	HDDV5	HDDV6	HDDV7	HDDV8A	HDDV8B		
-----	-----	-----	-----	-----	-----	-----	-----	-----		
VMT Mix:	0.0096	0.0028	0.0022	0.0009	0.0055	0.0084	0.0107	0.0382		

Composite Emission Factors (g/mi):										
Composite VOC :	0.57	0.66	0.74	0.72	1.11	1.41	1.62	2.07		

APPENDIX E
CAL3QHC MODELING FILES

(Please download: Appendix E CAL3QHC Modeling Files.zip)

APPENDIX F
ISCST3 MODELING FILES

(Please download: [Appendix F ISCST3 Modeling Files.zip](#))

APPENDIX G

PSD CALCULATIONS

APPENDIX G
Maximum Predicted 24- hour PM₁₀ Concentrations (µg/m³) without Background
Yellowstone, Grand Teton & John D. Rockefeller, Jr. Memorial Pkwy

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		24-hour (ug/m ³)	24-hour (ug/m ³)	24-hour (ug/m ³)	24-hour (ug/m ³)
Alternative 1a	Current Plan	7.0	0.4	0.1	0.9
Alternative 1b	Current Plan, East Entrance Closed	7.4	0.4	0.2	1.0
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	7.0	0.4	0.1	0.9
Alternative 1e	Experimental Closure Gibbon Canyon	7.0	0.4	0.2	0.9
Alternative 2	Snowcoaches Only	0.0	0.0	0.0	0.0
Alternative 3*	Eliminate Most Road Grooming	0.0	0.0	0.0	0.8
Alternative 4	Enhanced Recreational Use	8.2	0.8	0.2	0.9
Alternative 5	Provide for Unguided Access	7.4	0.8	0.1	0.8
Alternative 6**	Mixed Use (West-side Roads Plowing)	18.9	24.2	4.7	0.8
1999 Historical***	Historical Unregulated Scenario	191.5	40.2	2.2	8.5
PSD Baseline Year	1979 Historical Conditions	42.5	8.9	0.4	0.8

Note:

Baseline Year concentrations are based on the ratio of 1979 to 1999 snowmobile levels at the modeling locations.

Class I PSD Increment for 24-hour average PM₁₀ is 8 µg/m³

* No modeled increment for Sites 1 and 2, since no West Entrance and Madison oversnow access for Alternative 3.

** For Site 2, Class I PSD Increment is exceeded.

*** For Sites 1 and 2, Class I PSD Increment is exceeded.

Peak Hour Snowmobile Volume Comparison
Dispersion Modeling Input Volumes

Modeling Year	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
1979	138	138	165	24
1999	623	623	864	273
1979 to 1999 Ratio	22%	22%	19%	9%

	West Entrance Daily Entry Limit	West Entrance to Madison Trips	Daily One-way Trips on Road Segments to Old Faithful	South Entrance Daily Entry Limit
1979	210	Same as WE	220	37
1999	947	Same as WE	1,152	415
Peak Hour (% of Daily Trips)	65.8%		75.0%	65.8%

1979 Baseline Year - Historical Unregulated Conditions

Snowmobiles	West Entrance 210		South Entrance 37		East Entrance 16		North Entrance 13		Old Faithful 0		Total 276
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	10.5	0.03	1.11	0.1	1.6	1.8	23.4	0.3	0	37
West Entrance to Madison	1.8	378	0.05	1.85	0.1	1.6	0.15	1.95	0.15	0	383
Madison to Norris	0.59	123.9	0.08	2.96	0.1	1.6	1.2	15.6	1	0	144
Norris to Canyon Village	0.44	92.4	0.05	1.85	0.2	3.2	0.56	7.28	0.7	0	105
Canyon Village to Fishing Bridge	0.34	71.4	0.45	16.65	1.4	22.4	0.36	4.68	0.7	0	115
Fishing Bridge to East Entrance	0.02	4.2	0.05	1.85	1.6	25.6	0.02	0.26	0.02	0	32
Fishing Bridge to West Thumb	0.08	16.8	0.46	17.02	0.3	4.8	0.02	0.26	0.7	0	39
Madison to Old Faithful*	1.41	296.1	0.47	17.39	0.1	1.6	1.15	14.95	1.05	0	330
Old Faithful to West Thumb*	0.27	56.7	1.35	49.95	0.2	3.2	0.05	0.65	0.75	0	111
West Thumb to Flagg Ranch	0.05	10.5	1.75	64.75	0.1	1.6	0.05	0.65	0.05	0	78

* Used to determine Old Faithful visits

Snowcoaches	West Entrance 7		South Entrance 5		East Entrance 0		North Entrance 0		Old Faithful 0		Total 12
YELL Road Segment	Factor	Results	Factor	Results	Factor	Results	Factor	Results	Factor	Results	
Mammoth to Norris	0.05	0.36556	0.03	0.143	0.1	0	1.8	0	0	0	1
West Entrance to Madison	1.8	13.16	0.05	0.23833	0.1	0	0.15	0	0.48	0	13
Madison to Norris	0.59	4.31356	0.08	0.38133	0.1	0	1.2	0	0.06	0	5
Norris to Canyon Village	0.44	3.21689	0.05	0.23833	0.2	0	0.56	0	0.06	0	3
Canyon Village to Fishing Bridge	0.34	2.48578	0.45	2.145	1.4	0	0.36	0	0.06	0	5
Fishing Bridge to East Entrance	0.02	0.14622	0.05	0.23833	1.6	0	0.02	0	0	0	0
Fishing Bridge to West Thumb	0.08	0.58489	0.46	2.19267	0.3	0	0.02	0	0.06	0	3
Madison to Old Faithful	1.41	10.3087	0.47	2.24033	0.1	0	1.15	0	0.6	0	13
Old Faithful to West Thumb	0.27	1.974	1.35	6.435	0.2	0	0.05	0	1.3	0	8
West Thumb to Flagg Ranch	0.05	0.36556	1.75	8.34167	0.1	0	0.05	0	1.18	0	9

Snowmobiles	CDST N/A		Grassy Lake Rd N/A		Jackson Lake N/A		Totals 0
GRTE Road Segment	Factor	Results	Factor	Results	Factor	Results	
Moran Junction to Flagg Ranch	2	N/A	0	0	0	0	N/A
Flagg Ranch west to boundary	0	0	1.9	N/A	0	0	N/A
Jackson Lake fishing access	0	0	0	0	2	N/A	N/A

NOTES:

CDST did not exist in 1979 and no GRTE or Grassy Lake statistics available.

APPENDIX H
EMISSIONS INVENTORY FILES

**Maximum Predicted 1- and 8-hour CO Concentrations (parts per million)
Yellowstone, Grand Teton & John D. Rockefeller, Jr. Memorial Pkway**

Scenario	Description	Site 1: West Entrance		Site 2: West Entrance to Madison		Site 3: Old Faithful Staging Area		Site 4: Flagg Ranch Staging Area	
		1-hour (ppm)	8-hour (ppm)	1-hour (ppm)	8-hour (ppm)	1-hour (ppm)	8-hour (ppm)	1-hour (ppm)	8-hour (ppm)
Alternative 1a	Current Plan	6.4	2.1	1.4	0.5	0.7	0.4	4.7	2.1
Alternative 1b	Current Plan, East Entrance Closed	6.7	2.2	1.1	0.4	0.7	0.4	5.3	2.3
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	6.4	2.1	1.1	0.4	0.7	0.4	4.8	2.1
Alternative 1e	Experimental Closure Gibbon Canyon	6.4	2.1	1.1	0.4	0.8	0.4	4.7	2.1
Alternative 2	Snowcoaches Only	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2
Alternative 3*	Eliminate Most Road Grooming	0.2	0.2	0.2	0.2	0.4	0.2	4.4	2.0
Alternative 4	Enhanced Recreational Use	7.7	2.5	1.5	0.6	0.9	0.5	6.4	2.8
Alternative 5	Provide for Unguided Access	4.3	1.4	0.6	0.3	0.5	0.3	2.9	1.3
Alternative 6	Mixed Use (West-side Roads Plowing)	2.0	0.7	0.4	0.2	0.5	0.3	4.4	2.0
Current Conditions	Current Conditions / Actual Use Scenario	3.7	1.2	0.7	0.3	0.4	0.3	1.8	0.9
1999 Historical	Historical Unregulated Scenario	23.7	7.4	21.0	6.6	1.7	0.8	8.7	3.8

Note:

* Background levels only for Sites 1 and 2, since no West Entrance and Madison oversnow access for Alternative 3.

NAAQS for CO are 35 and 9 parts per million (ppm), for the 1-hour and 8-hour averaging periods, respectively.

Location	CO Backgrounds (ppm) and Persistence Factor		
	1-hr	8-hr	Persistence
West Entrance	0.17	0.15	0.31
Old Faithful	0.17	0.15	0.43

Maximum Predicted 24- hour PM_{2.5} Concentrations (µg/m³)
Yellowstone, Grand Teton & John D. Rockefeller, Jr. Memorial Pkway

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		24-hour (ug/m ³)	24-hour (ug/m ³)	24-hour (ug/m ³)	24-hour (ug/m ³)
Alternative 1a	Current Plan	9.4	2.8	2.5	3.3
Alternative 1b	Current Plan, East Entrance Closed	9.8	2.8	2.6	3.4
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	9.4	2.8	2.5	3.3
Alternative 1e	Experimental Closure Gibbon Canyon	9.4	2.8	2.6	3.3
Alternative 2	Snowcoaches Only	2.4	2.4	2.4	2.4
Alternative 3*	Eliminate Most Road Grooming	2.4	2.4	2.4	3.2
Alternative 4	Enhanced Recreational Use	10.6	3.2	2.6	3.3
Alternative 5	Provide for Unguided Access	9.8	3.2	2.5	3.2
Alternative 6	Mixed Use (West-side Roads Plowing)	21.3	26.6	7.1	3.2
Current Conditions	Current Conditions / Actual Use Scenario	6.1	2.8	2.5	2.7
1999 Historical	Historical Unregulated Scenario	193.9	42.6	4.6	10.9
Note: * Background levels only for Sites 1 and 2, since no West Entrance and Madison oversnow access for Alternative 3. NAAQS for PM ₁₀ is 150 µg/m ³ and for PM _{2.5} is 65 µg/m ³ , for the 24-hour averaging period.					

Location	PM _{2.5} Backgrounds (ug/m ³) and Persistence Factor	
	24-hr	Persistence
WEST ENTRANCE	2.4	0.41
OLD FAITHFUL	2.4	0.15

Total Percent Comparison to Current and Historic Use Levels for 8-hour CO
Yellowstone, Grand Teton & John D. Rockefeller, Jr. Memorial Pkwy

Scenario	Description	Site 1: West Entrance		Site 2: West Entrance to Madison		Site 3: Old Faithful Staging Area		Site 4: Flagg Ranch Staging Area	
		% Concentrations of :							
		Current Conditions	1999 Historical	Current Conditions	1999 Historical	Current Conditions	1999 Historical	Current Conditions	1999 Historical
Alternative 1a	Current Plan	168%	28%	171%	8%	149%	47%	244%	56%
Alternative 1b	Current Plan, East Entrance Closed	175%	29%	141%	7%	155%	49%	270%	62%
Alternative 1d	East Ent Closed & Elim. 40 Snowmobile	168%	28%	141%	7%	149%	47%	244%	56%
Alternative 1e	Experimental Closure Gibbon Canyon	168%	28%	141%	7%	165%	52%	244%	56%
Alternative 2	Snowcoaches Only	15%	2%	59%	3%	63%	20%	21%	5%
Alternative 3	Eliminate Most Road Grooming	12%	2%	49%	2%	97%	31%	229%	52%
Alternative 4	Enhanced Recreational Use	200%	33%	181%	8%	183%	58%	325%	74%
Alternative 5	Provide for Unguided Access	115%	19%	90%	4%	115%	36%	155%	35%
Alternative 6	Mixed Use (West-side Roads Plowing)	57%	10%	70%	3%	111%	35%	228%	52%
Current Conditions	Current Conditions / Actual Use Scenario	100%	17%	100%	5%	100%	31%	100%	23%
1999 Historical	Historical Unregulated Scenario	602%	100%	2163%	100%	317%	100%	438%	100%

Note:
Percentages determined using modeled concentrations, including background levels.

Total Percent Comparison to Current and Historic Use for 24-hour PM_{2.5}
Yellowstone, Grand Teton & John D. Rockefeller, Jr. Memorial Pkwy

Scenario	Description	Site 1: West Entrance		Site 2: West Entrance to Madison		Site 3: Old Faithful Staging Area		Site 4: Flagg Ranch Staging Area	
		% Concentrations of :							
		Current Conditions	1999 Historical	Current Conditions	1999 Historical	Current Conditions	1999 Historical	Current Conditions	1999 Historical
Alternative 1a	Current Plan	154%	5%	100%	7%	104%	55%	122%	30%
Alternative 1b	Current Plan, East Entrance Closed	161%	5%	100%	7%	104%	55%	126%	31%
Alternative 1d	East Ent Closed & Elim. 40 Snowmobile	154%	5%	100%	7%	104%	55%	122%	30%
Alternative 1e	Experimental Closure Gibbon Canyon	154%	5%	100%	7%	105%	55%	122%	30%
Alternative 2	Snowcoaches Only	39%	1%	85%	6%	98%	52%	91%	22%
Alternative 3	Eliminate Most Road Grooming	39%	1%	85%	6%	98%	52%	120%	29%
Alternative 4	Enhanced Recreational Use	174%	5%	115%	8%	106%	56%	125%	31%
Alternative 5	Provide for Unguided Access	161%	5%	115%	8%	104%	55%	119%	29%
Alternative 6	Mixed Use (West-side Roads Plowing)	349%	11%	946%	62%	290%	153%	119%	29%
Current Conditions	Current Conditions / Actual Use Scenario	100%	3%	100%	7%	100%	53%	100%	24%
1999 Historical	Historical Unregulated Scenario	3183%	100%	1515%	100%	189%	100%	408%	100%

Note:
Percentages determined using modeled concentrations, including background levels.

VISCREEN Visibility Analysis Results

Scenario	Description	Screening Criteria Exceedance			
		Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful	Site 4: Flagg Ranch
Alternative 1a	Current Plan	No	No	No	No
Alternative 1b	Current Plan, East Entrance Closed	No	No	No	No
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	No	No	No	No
Alternative 1e	Experimental Closure Gibbon Canyon	No	No	No	No
Alternative 2	Snowcoaches Only	No	No	No	No
Alternative 3	Eliminate Most Road Grooming	No	No	No	No
Alternative 4	Enhanced Recreational Use	No	No	No	No
Alternative 5	Provide for Unguided Access	No	No	No	No
Alternative 6	Mixed Use (West-side Roads Plowing)	Yes	No	Yes	No
Current Conditions	Current Conditions / Actual Use Scenario	No	No	No	No
1999 Historical	Historical Unregulated Scenario	Yes	No	No	Yes

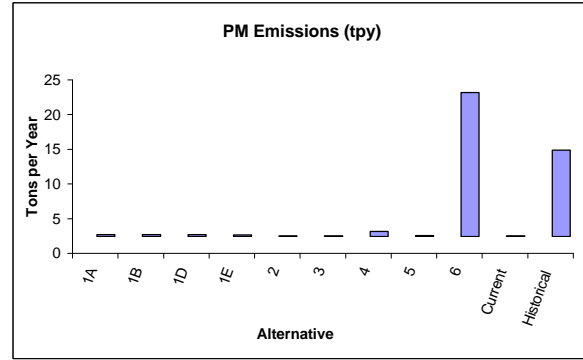
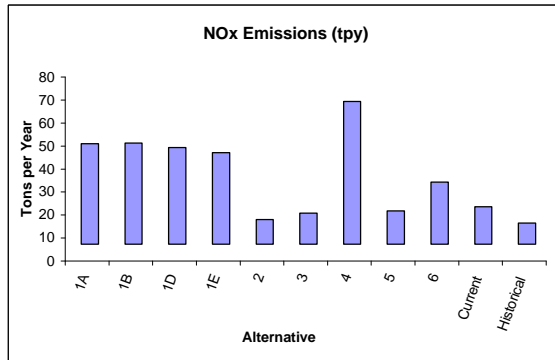
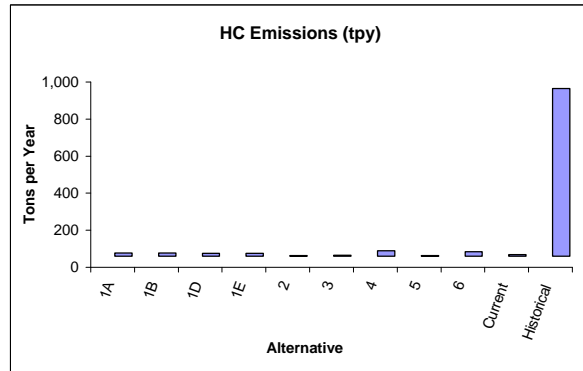
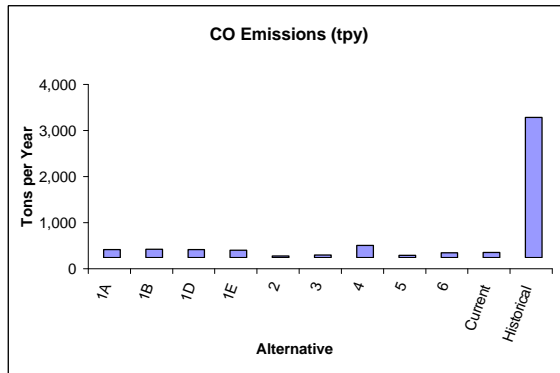
VISCREEN Visibility Analysis Results

Scenario	Description	Screening Criteria Exceedance			
		Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful	Site 4: Flagg Ranch
Alternative 1a	Current Plan	No	No	No	No
Alternative 1b	Current Plan, East Entrance Closed	No	No	No	No
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	No	No	No	No
Alternative 1e	Experimental Closure Gibbon Canyon	No	No	No	No
Alternative 2	Snowcoaches Only	No	No	No	No
Alternative 3	Eliminate Most Road Grooming	No	No	No	No
Alternative 4	Enhanced Recreational Use	No	No	No	No
Alternative 5	Provide for Unguided Access	No	No	No	No
Alternative 6	Mixed Use (West-side Roads Plowing)	Yes	No	Yes	No
Current Conditions	Current Conditions / Actual Use Scenario	No	No	No	No
1999 Historical	Historical Unregulated Scenario	Yes	No	No	Yes

**Table 6-1: Summary of Parkwide Total Winter Season Mobile Source Emissions
Yellowstone, Grand Teton & John D. Rockefeller, Jr. Memorial Pkway**

Scenario	Description	CO		HC		NOx		PM	
		lb/day	tpy	lb/day	tpy	lb/day	tpy	lb/day	tpy
Alternative 1a	Current Plan	3,934	177	372	17	969	44	6	0.3
Alternative 1b	Current Plan, East Entrance Closed	3,967	179	375	17	977	44	6	0.3
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	3,788	170	357	16	933	42	6	0.3
Alternative 1e	Experimental Closure Gibbon Canyon	3,592	162	338	15	884	40	5	0.2
Alternative 2	Snowcoaches Only	827	37	22	1	239	11	1	0.0
Alternative 3	Eliminate Most Road Grooming	1,267	57	126	6	301	14	2	0.1
Alternative 4	Enhanced Recreational Use	5,939	267	640	29	1,379	62	16	0.7
Alternative 5	Provide for Unguided Access	2,115	50	153	3	616	14	6	0.1
Alternative 6	Mixed Use (West-side Roads Plowing)	2,306	104	554	25	600	27	462	20.8
Current Conditions	Current Conditions / Actual Use Scenario	2,523	114	188	8	362	16	2	0.1
1999 Historical*	Historical Unregulated Scenario	67,662	3,045	20,109	905	203	9	277	12.5

Note:
All Alternatives and scenarios assume current snowmobile BAT, except:
- Alternative 5, which assumes Improved BAT and;
- Historical Conditions, which assumes all uncontrolled 2-stroke.
* For comparison purposes, this scenario was also modeled for the year 2010. The winter season emissions would be as follows: CO - 1,124 tpy; HC - 341 tpy; NOx - 8 tpy; PM - 12 tpy.
2010 conditions assumes standard snowmobile replacement rates based on EPA's 2006 and 2010 emissions restrictions.
For all Alternatives, Grassy Lake Road emissions from snowmobiles originating in Targhee NF assume 2007 engine mix; 20% uncontrolled 2-stroke, 70% modified & direct injection 2-stroke, and 10% 4-stroke.



Summary of Emissions

Summary of Emissions By Scenario and Link (lb/day)

CO

Link	Alternative 1a (lb/day)	Alternative 1b (lb/day)	Alternative 1d (lb/day)	Alternative 1e (lb/day)	Alternative 2 (lb/day)	Alternative 3 (lb/day)	Alternative 4 (lb/day)	Alternative 5 (lb/day)	Alternative 6 (lb/day)	Current (lb/day)	Historical (lb/day)
West	13.67	14.47	13.68	13.68	0.85	0.00	20.50	6.70	2.16	7.07	184.08
Mammoth to Norris	145.15	120.71	140.54	143.36	61.04	0.00	175.04	118.32	60.26	161.06	1617.50
West Entrance to Madison	612.02	638.67	609.01	612.10	135.86	0.00	912.42	319.43	79.60	417.87	13458.04
Madison to Norris	273.67	267.27	270.78	0.00	67.10	0.00	391.34	157.72	40.92	203.62	5269.11
Norris to Canyon Village	165.89	160.44	160.59	63.04	37.18	0.00	244.84	92.05	11.42	116.42	3309.14
Canyon Village to Fishing Bridge	296.00	258.03	246.92	187.32	51.08	0.00	458.63	154.11	267.36	183.93	5264.25
Fishing Bridge to East Entrance	129.03	33.73	31.17	31.17	6.19	0.00	277.00	72.76	0.00	61.95	2004.76
Fishing Bridge to West Thumb	193.80	193.89	181.94	271.15	31.54	0.00	270.72	90.58	367.57	109.95	3176.53
Madison to Old Faithful	702.44	723.94	700.73	782.53	167.28	0.00	1006.55	380.43	102.03	494.12	13993.65
Old Faithful to West Thumb	443.31	481.82	441.45	536.00	114.99	486.71	583.32	228.62	529.50	285.36	6937.93
West Thumb to Flagg Ranch	583.43	696.22	615.35	572.91	152.39	687.12	716.43	289.44	587.61	379.31	8108.90
GTNP CDST	121.06	121.06	121.06	121.06	0.00	0.00	296.72	56.56	0.00	0.00	1540.86
GTNP Grassy	71.46	71.46	71.46	71.46	0.00	73.23	155.26	58.27	84.80	51.34	320.21
GTNP Jackson Lake	150.51	150.51	150.51	150.51	0.00	0.00	376.29	70.33	150.51	37.63	2394.76
Old Faithful Staging Area	21.06	22.29	20.95	24.60	0.81	8.91	28.98	13.12	12.12	9.49	60.40
Flagg Ranch Staging Area	11.37	12.70	11.43	11.36	0.30	10.66	25.45	6.95	10.55	4.36	21.64
Total	3933.89	3967.21	3787.58	3592.24	826.61	1266.63	5939.46	2115.39	2306.41	2523.47	67661.77

HC

Link	Alternative 1a (lb/day)	Alternative 1b (lb/day)	Alternative 1d (lb/day)	Alternative 1e (lb/day)	Alternative 2 (lb/day)	Alternative 3 (lb/day)	Alternative 4 (lb/day)	Alternative 5 (lb/day)	Alternative 6 (lb/day)	Current (lb/day)	Historical (lb/day)
West	1.26	1.33	1.26	1.26	0.09	0.00	1.88	0.44	0.14	0.53	150.93
Mammoth to Norris	11.23	8.79	10.79	10.63	1.58	0.00	13.12	6.46	3.81	8.24	478.44
West Entrance to Madison	55.47	58.18	55.17	55.87	3.51	0.00	82.93	20.35	5.03	29.56	4240.76
Madison to Norris	24.32	23.67	24.03	0.00	1.73	0.00	34.84	9.85	2.59	13.24	1651.50
Norris to Canyon Village	14.92	14.40	14.42	4.76	0.96	0.00	22.11	5.86	0.98	7.81	1040.38
Canyon Village to Fishing Bridge	27.31	23.76	22.63	14.85	1.32	0.00	42.34	10.38	23.02	13.01	1659.87
Fishing Bridge to East Entrance	11.99	3.14	2.88	2.88	0.16	0.00	26.28	5.23	0.00	4.29	635.61
Fishing Bridge to West Thumb	18.34	18.29	17.08	22.72	0.82	0.00	25.26	6.35	31.84	8.38	1004.24
Madison to Old Faithful	63.06	65.13	62.78	71.54	4.32	0.00	90.25	23.91	6.45	33.89	4393.90
Old Faithful to West Thumb	39.74	43.26	39.17	47.92	2.97	44.93	51.20	14.10	48.26	20.61	2160.49
West Thumb to Flagg Ranch	52.72	63.38	55.19	53.82	3.94	63.44	62.48	18.00	57.19	27.91	2516.73
GTNP CDST	12.26	12.26	12.26	12.26	0.00	0.00	82.51	4.76	0.00	0.00	14.72
GTNP Grassy	17.75	17.75	17.75	17.75	0.00	14.36	58.93	16.51	355.92	14.36	3.06
GTNP Jackson Lake	15.25	15.25	15.25	15.25	0.00	0.00	38.12	5.92	15.25	3.81	22.87
Old Faithful Staging Area	3.93	4.16	3.91	4.58	0.22	1.66	5.41	3.38	1.73	1.51	99.79
Flagg Ranch Staging Area	2.11	2.36	2.12	2.10	0.08	1.98	2.65	1.79	1.94	0.73	35.96
Total	371.66	375.10	356.70	338.22	21.70	126.36	640.31	153.28	554.14	187.88	20109.25

Summary of Emissions

NO_x

Link	Alternative 1a (lb/day)	Alternative 1b (lb/day)	Alternative 1d (lb/day)	Alternative 1e (lb/day)	Alternative 2 (lb/day)	Alternative 3 (lb/day)	Alternative 4 (lb/day)	Alternative 5 (lb/day)	Alternative 6 (lb/day)	Current (lb/day)	Historical (lb/day)
West	1.19	1.25	1.19	1.19	0.40	0.00	1.78	0.58	0.50	0.55	0.51
Mammoth to Norris	37.73	31.70	36.58	37.53	17.67	0.00	45.75	35.30	18.30	14.12	10.86
West Entrance to Madison	154.47	161.02	153.72	154.26	39.32	0.00	230.15	96.19	24.17	62.49	37.22
Madison to Norris	69.35	67.77	68.63	0.00	19.42	0.00	99.13	47.44	12.42	26.75	16.38
Norris to Canyon Village	41.93	40.57	40.61	16.46	10.76	0.00	61.84	27.72	3.18	16.06	9.64
Canyon Village to Fishing Bridge	74.43	64.91	62.18	48.49	14.78	0.00	115.31	46.58	74.30	27.49	14.34
Fishing Bridge to East Entrance	32.40	8.47	7.83	7.83	1.79	0.00	69.24	22.10	0.00	8.97	4.75
Fishing Bridge to West Thumb	48.47	48.53	45.59	69.49	9.13	0.00	67.91	27.46	101.75	18.34	8.11
Madison to Old Faithful	177.63	182.99	177.27	197.15	48.41	0.00	254.60	114.47	30.98	70.52	41.90
Old Faithful to West Thumb	112.14	121.84	111.90	135.65	33.28	122.37	148.18	68.70	141.59	44.00	24.45
West Thumb to Flagg Ranch	147.34	175.56	155.64	143.51	44.10	172.76	182.22	87.03	149.58	60.15	30.29
GTNP CDST	29.81	29.81	29.81	29.81	0.00	0.00	30.57	17.39	0.00	0.00	1.46
GTNP Grassy	5.09	5.09	5.09	5.09	0.00	5.53	8.47	3.03	5.72	3.30	0.30
GTNP Jackson Lake	37.07	37.07	37.07	37.07	0.00	0.00	63.34	21.62	37.07	9.27	2.27
Old Faithful Staging Area	0.15	0.16	0.15	0.17	0.05	0.06	0.21	0.07	0.46	0.05	0.13
Flagg Ranch Staging Area	0.07	0.08	0.07	0.07	0.02	0.07	0.14	0.07	0.06	0.02	0.05
Total	969.29	976.82	933.34	883.78	239.13	300.78	1378.83	615.75	600.08	362.09	202.67

PM-10

Link	Alternative 1a (lb/day)	Alternative 1b (lb/day)	Alternative 1d (lb/day)	Alternative 1e (lb/day)	Alternative 2 (lb/day)	Alternative 3 (lb/day)	Alternative 4 (lb/day)	Alternative 5 (lb/day)	Alternative 6 (lb/day)	Current (lb/day)	Historical (lb/day)
West	0.03	0.03	0.03	0.03	0.00	0.00	0.04	0.02	1.95	0.01	3.13
Mammoth to Norris	0.19	0.16	0.19	0.19	0.06	0.00	0.23	0.26	96.93	0.06	6.12
West Entrance to Madison	0.82	0.86	0.82	0.82	0.11	0.00	1.23	0.80	128.04	0.31	54.74
Madison to Norris	0.37	0.36	0.36	0.00	0.06	0.00	0.53	0.39	65.81	0.13	21.30
Norris to Canyon Village	0.22	0.22	0.22	0.08	0.03	0.00	0.33	0.23	0.02	0.08	13.43
Canyon Village to Fishing Bridge	0.40	0.35	0.33	0.25	0.04	0.00	0.62	0.41	0.39	0.14	21.43
Fishing Bridge to East Entrance	0.17	0.05	0.04	0.04	0.00	0.00	0.37	0.20	0.00	0.04	8.21
Fishing Bridge to West Thumb	0.26	0.26	0.25	0.36	0.02	0.00	0.36	0.25	0.53	0.09	12.97
Madison to Old Faithful	0.94	0.97	0.94	1.05	0.14	0.00	1.35	0.95	164.11	0.35	56.69
Old Faithful to West Thumb	0.60	0.65	0.59	0.72	0.10	0.66	0.78	0.56	0.75	0.22	27.84
West Thumb to Flagg Ranch	0.78	0.94	0.83	0.77	0.12	0.93	0.96	0.71	0.81	0.31	32.42
GTNP CDST	0.16	0.16	0.16	0.16	0.00	0.00	2.83	0.18	0.00	0.00	6.47
GTNP Grassy	0.62	0.62	0.62	0.62	0.00	0.63	0.79	0.63	0.35	0.02	1.34
GTNP Jackson Lake	0.20	0.20	0.20	0.20	0.00	0.00	5.87	0.22	0.20	0.05	10.06
Old Faithful Staging Area	0.05	0.06	0.05	0.06	0.00	0.00	0.07	0.05	1.68	0.02	0.79
Flagg Ranch Staging Area	0.03	0.03	0.03	0.03	0.00	0.03	0.00	0.03	0.03	0.01	0.29
Total	5.87	5.92	5.67	5.41	0.69	2.24	16.38	5.90	461.59	1.84	277.22

Percent Contribution by Vehicle Type to Total Scenario Emissions

Scenario	Description	CO			HC			NOx			PM		
		Snowmobile	Snowcoach	On-road Vehicle	Snowmobile	Snowcoach	On-road Vehicle	Snowmobile	Snowcoach	On-road Vehicle	Snowmobile	Snowcoach	On-road Vehicle
Alternative 1a	Current Plan	86%	14%	na	96%	4%	na	84%	16%	na	88%	12%	na
Alternative 1b	Current Plan, East Entrance Closed	87%	13%	na	96%	4%	na	84%	16%	na	88%	12%	na
Alternative 1d	East Ent Closed & Elim. 40 Snowmobile	86%	14%	na	96%	4%	na	83%	17%	na	88%	12%	na
Alternative 1e	Experimental Closure Gibbon Canyon	86%	14%	na	96%	4%	na	83%	17%	na	88%	12%	na
Alternative 2	Snowcoaches Only	0%	100%	na	0%	100%	na	0%	100%	na	0%	100%	na
Alternative 3	Eliminate Most Road Grooming	89%	11%	na	97%	3%	na	87%	13%	na	92%	8%	na
Alternative 4	Enhanced Recreational Use	87%	13%	na	97%	3%	na	83%	17%	na	94%	6%	na
Alternative 5	Provide for Unguided Access	68%	32%	na	88%	12%	na	68%	32%	na	85%	15%	na
Alternative 6	Mixed Use (West-side Roads Plowing)	78%	10%	12%	96%	1%	3%	70%	15%	14%	1%	0%	99%
Current Conditions	Current Conditions / Actual Use Scenario	47%	53%	na	70%	30%	na	77%	23%	na	86%	14%	na
1999 Historical	Historical Unregulated Scenario	96%	4%	na	99%	1%	na	30%	70%	na	100%	0%	na

Summary of Parkwide Total Winter Season HAPs Mobile Source Emissions (Tons per Year)
Yellowstone, Grand Teton & John D. Rockefeller, Jr. Memorial Pkway

Scenario	Description	Benzene (tpy)	1-3 Butadiene (tpy)	Formaldehyde (tpy)	Acetaldehyde (tpy)
Alternative 1a	Current Plan	0.44	0.00	0.46	0.18
Alternative 1b	Current Plan, East Entrance Closed	0.44	0.00	0.47	0.18
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	0.42	0.00	0.44	0.17
Alternative 1e	Experimental Closure Gibbon Canyon	0.40	0.00	0.42	0.16
Alternative 2	Snowcoaches Only	0.03	0.01	0.02	0.00
Alternative 3	Eliminate Most Road Grooming	0.15	0.00	0.16	0.06
Alternative 4	Enhanced Recreational Use	0.76	0.01	0.80	0.31
Alternative 5	Provide for Unguided Access	0.19	0.00	0.18	0.07
Alternative 6	Mixed Use (West-side Roads Plowing)	0.66	0.01	0.70	0.27
Current Conditions	Current Conditions / Actual Use Scenario	0.24	0.01	0.21	0.08
1999 Historical	Historical Unregulated Scenario	5.95	1.02	6.12	4.25
Note: 2-stroke and 4-stroke snowmobile HAPs estimated as a fraction of measured HC emissions based on data reported in SwRI's <i>Laboratory Testing of Snowmobile Emissions</i> , Lela and White, July 2002. Snowcoach and on-road vehicle HAPs estimated as a fraction of HC emissions based on MOBILE6 modeling of HC and air toxics emission factors for light- and heavy-duty vehicles.					

Summary of Daily Snowmobile, Snowcoach, and Wheeled Vehicles Use Numbers from Yellowstone 21June2006 Travel Factors Spreadsheet

Snowmobiles

Link	Alternative 1a	Alternative 1b	Alternative 1d	Alternative 1e	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Current	Historical
West Entrance	400	424	400	400	0	0	600	336	0	153	947
Mammoth to Norris	93.6	71	90	87	0	0	108	117.94	0	21.62	129.15
West Entrance to Madison	744	782	740	752	0	0	1114	629.05	0	282.15	1738.45
Madison to Norris	323.6	315	320	0	0	0	464	300.48	0	109.19	676.33
Norris to Canyon Village	232.8	225	225	69	0	0	346	211.5	15	79.67	497.36
Canyon Village to Fishing Bridge	322.8	281	267	164	0	0	501	291.1	265	108.57	595.46
Fishing Bridge to East Entrance	84.2	22	20	20	0	0	186	90.22	0	20.51	135.26
Fishing Bridge to West Thumb	166.8	166	155	197	0	0	229	139.18	280	59.18	274.62
Madison to Old Faithful	737.4	762	733	843	0	0	1055	640.67	0	269.36	1575.02
Old Faithful to West Thumb	437	476	429	527	0	500	558	350.77	535	167.06	727.74
West Thumb to Flagg Ranch	412	497	430	427	0	500	481	319.15	460	164.7	600.1
Old Faithful	587.2	619.12	581.2	684.55	0	250	806.5	495.72	267.5	218.21	1151.38
Flagg Ranch*	320	356	320	320	0	300	400	268	300	109	415

*Based on total daily snowmobile entry limits for the South Entrance, CDST and Grassy Lake Rd combined.

Snowcoaches

Link	Alternative 1a	Alternative 1b	Alternative 1d	Alternative 1e	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Current	Historical
West Entrance	34	34	34	34	55	0	50	44	0	14	20
Mammoth to Norris	25.7	25.49	25.49	28.84	34.1	0	34.17	33.49	0	11.75	10.31
West Entrance to Madison	72.59	72.44	72.44	68.16	113.84	0	105.52	93.74	0	27.89	40.56
Madison to Norris	37.84	37.78	37.78	0	56.23	0	53.36	49.08	0	16.14	18.88
Norris to Canyon Village	24.42	23.97	23.97	21.04	36.35	0	34.91	31.51	3.2	10.15	12.57
Canyon Village to Fishing Bridge	26.02	23.17	23.17	40.06	37.45	0	40.11	32.51	54.8	10.75	13.57
Fishing Bridge to East Entrance	6.24	1.59	1.59	1.59	2.69	0	10.29	6.67	0	2.25	2.45
Fishing Bridge to West Thumb	9.56	10.04	10.04	35.14	17.62	0	16.02	12.12	55.4	4.02	5.64
Madison to Old Faithful	78.69	79.8	79.8	75.16	122.65	0	113.88	101.8	0	30.89	41.54
Old Faithful to West Thumb	47.33	50.78	50.78	58.33	79.35	40	72.2	60.78	68.2	14.93	24.4
West Thumb to Flagg Ranch	41.39	46.34	46.34	27.31	74.49	40	65.42	53.24	21	13.39	21.86
Old Faithful	63.01	65.29	65.29	66.745	101	20	93.04	81.29	34.1	22.91	32.97
Flagg Ranch**	20.695	23.17	23.17	13.655	37.245	20	32.71	26.62	10.5	6.695	10.93

**Based on half of trips (two-way) of West Thumb to Flagg Ranch link, since greater than South Entrance daily entry limit.

Snowmobiles

Link	Alternative 1a	Alternative 1b	Alternative 1d	Alternative 1e	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Current	Historical
GTNP CDST	100	100	100	100	0	0	150	100	0	0	120
GTNP Grassy	95	95	95	95	0	100	142.5	95	95	38	85.5
GTNP Jackson Lake	80	80	80	80	0	0	200	80	80	20	120

Note: West Entrance numbers are based on total daily admission--no factors applied.

For Alternative 6, ONLY

Wheeled Vehicles

Link	Scenario I
West Entrance	75
Mammoth to Norris	67.5
West Entrance to Madison	133.75
Madison to Norris	68.75
Norris to Canyon Village	0
Canyon Village to Fishing Bridge	0
Fishing Bridge to East Entrance	0
Fishing Bridge to West Thumb	0
Madison to Old Faithful	150
Old Faithful to West Thumb	0
West Thumb to Flagg Ranch	0
Old Faithful	75
Flagg Ranch	0

Alternative 1a

CO Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			% Snowmobiles	Idle Time (hr)
		15 mph (g/veh-mi)	35 mph (g/veh-mi)	Idle (g/hr)		
Snowmobile	2-Stroke	220.6	242.9	266	20%	0.0083
Snowmobile	Phase 1 2-Stroke	80.4	52.5	266	70%	0.083
Snowmobile	Current BAT	35.1	22.9	191.5	10%	
Snowmobile	Improved BAT	18.4	10.7	137.6		
Snowcoach	BAT	17.4	38.7	43.7		

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g/veh-link)	Snowcoach Unit Emissions (g/veh-link)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	14.92745	6.97471	13.15	0.52	14
Mammoth to Norris	21	480.9	812.7	99.15	46.01	145
West Entrance to Madison	14	320.6	541.8	525.39	86.63	612
Madison to Norris	14	320.6	541.8	228.52	45.16	274
Norris to Canyon Village	12	274.8	464.4	140.91	24.98	166
Canyon Village to Fishing Bridge	16	366.4	619.2	260.52	35.49	296
Fishing Bridge to East Entrance	27	618.3	1044.9	114.67	14.36	129
Fishing Bridge to West Thumb	21	480.9	812.7	176.68	17.11	194
Madison to Old Faithful	16	366.4	619.2	595.12	107.32	702
Old Faithful to West Thumb	17	389.3	657.9	374.72	68.59	443
West Thumb to Flagg Ranch	24	549.6	928.8	498.76	84.68	583
GTNP CDST	24	549.6	928.8	121.06	0.00	121
GTNP Grassy	7	160.3	270.9	71.46	0.00	71
GTNP Jackson Lake	37.3	854.17	1443.51	150.51	0.00	151
Old Faithful Staging Area	NA	15.89	3.63	20.56	0.50	21.06
Flagg Ranch Staging Area	NA	15.89	3.63	11.20	0.17	11.37
Total				3402.37	531.51	3933.89

HC Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	179.9	78.7	473	0.0083
Snowmobile	Phase 1 2-Stroke	18.8	15.5	235.3	0.083
Snowmobile	Current BAT	2.82	2.32	35.3	
Snowmobile	Improved BAT	0.56	0.9	35.3	
Snowcoach	BAT	1.6	1	12	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.36	0.71	1.20	0.05	1.26
Mammoth to Norris	21	48.72	21	10.04	1.19	11.23
West Entrance to Madison	14	32.48	14	53.23	2.24	55.47
Madison to Norris	14	32.48	14	23.15	1.17	24.32
Norris to Canyon Village	12	27.84	12	14.28	0.65	14.92
Canyon Village to Fishing Bridge	16	37.12	16	26.39	0.92	27.31
Fishing Bridge to East Entrance	27	62.64	27	11.62	0.37	11.99
Fishing Bridge to West Thumb	21	48.72	21	17.90	0.44	18.34
Madison to Old Faithful	16	37.12	16	60.29	2.77	63.06
Old Faithful to West Thumb	17	39.44	17	37.96	1.77	39.74
West Thumb to Flagg Ranch	24	55.68	24	50.53	2.19	52.72
GTNP CDST	24	55.68	24	12.26	0.00	12.26
GTNP Grassy	7	16.24	7	17.75	0.00	17.75
GTNP Jackson Lake	37.3	86.536	37.3	15.25	0.00	15.25
Old Faithful Staging Area	NA	2.9299	0.996	3.79	0.14	3.93
Flagg Ranch Staging Area	NA	2.9299	0.996	2.07	0.05	2.11
Total				357.72	13.94	371.66

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Peak Hour	# vehs / pk hr
Snowmobiles	400	65.8%	263
Snowcoaches	34	39.3%	13
Total			276

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	22.9	6023	22.90
Snowcoaches	38.7	503	38.70
Total		6526	23.64

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	35.1	9231	35.10
Snowcoaches	17.4	226	17.40
Total		9458	34.27

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	191.5	50365	191.50
Snowcoaches	43.7	568	43.70
Total		50933	184.54

Alternative 1a continued

NOx Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	0.2	0.23	0.53	0.0083	West Entrance Old Faithful/Flagg Ranch
Snowmobile	Current BAT	2.8	5.64	0.93	0.083	
Snowmobile	Improved BAT	0.91	3.29	1.05		
Snowcoach	BAT	8.6	11.2	4.4		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.071719	3.30452	0.94	0.25	1.19
Mammoth to Norris	21	118.44	235.2	24.42	13.31	37.73
West Entrance to Madison	14	78.96	156.8	129.40	25.07	154.47
Madison to Norris	14	78.96	156.8	56.28	13.07	69.35
Norris to Canyon Village	12	67.68	134.4	34.70	7.23	41.93
Canyon Village to Fishing Bridge	16	90.24	179.2	64.16	10.27	74.43
Fishing Bridge to East Entrance	27	152.28	302.4	28.24	4.16	32.40
Fishing Bridge to West Thumb	21	118.44	235.2	43.51	4.95	48.47
Madison to Old Faithful	16	90.24	179.2	146.57	31.06	177.63
Old Faithful to West Thumb	17	95.88	190.4	92.29	19.85	112.14
West Thumb to Flagg Ranch	24	135.36	268.8	122.84	24.51	147.34
GTNP CDST	24	135.36	268.8	29.81	0.00	29.81
GTNP Grassy	7	39.48	78.4	5.09	0.00	5.09
GTNP Jackson Lake	37.3	210.372	417.76	37.07	0.00	37.07
Old Faithful Staging Area	NA	0.07719	0.3652	0.10	0.05	0.15
Flagg Ranch Staging Area	NA	0.07719	0.3652	0.05	0.02	0.07
Total				815.49	153.79	969.29

PM Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	3.86	1.02	3.77	0.0083	West Entrance Old Faithful/Flagg Ranch
Snowmobile	Current BAT	0.065	0.031	0.49	0.083	
Snowmobile	Improved BAT	0.068	0.034	0.54		
Snowcoach	BAT	0.06	0.05	0.11		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.029	0.024	0.03	0.00	0.03
Mammoth to Norris	21	0.651	1.05	0.13	0.06	0.19
West Entrance to Madison	14	0.434	0.7	0.71	0.11	0.82
Madison to Norris	14	0.434	0.7	0.31	0.06	0.37
Norris to Canyon Village	12	0.372	0.6	0.19	0.03	0.22
Canyon Village to Fishing Bridge	16	0.496	0.8	0.35	0.05	0.40
Fishing Bridge to East Entrance	27	0.837	1.35	0.16	0.02	0.17
Fishing Bridge to West Thumb	21	0.651	1.05	0.24	0.02	0.26
Madison to Old Faithful	16	0.496	0.8	0.81	0.14	0.94
Old Faithful to West Thumb	17	0.527	0.85	0.51	0.09	0.60
West Thumb to Flagg Ranch	24	0.744	1.2	0.68	0.11	0.78
GTNP CDST	24	0.744	1.2	0.16	0.00	0.16
GTNP Grassy	7	0.217	0.35	0.62	0.00	0.62
GTNP Jackson Lake	37.3	1.1583	1.865	0.20	0.00	0.20
Old Faithful Staging Area	NA	0.041	0.01	0.05	0.00	0.054
Flagg Ranch Staging Area	NA	0.041	0.01	0.03	0.00	0.03
Total				5.18	0.69	5.87

West Entrance/West Entrance to Madison				
Vehicle Type	Vehicles/day	% Vehicles/Peak		# vehs / pk hr
		Hour		
Snowmobiles	400	65.8%		263
Snowcoaches	34	39.3%		13
Total				276
E- Factor (g/mi) @				
Vehicle Type	35 mph	g/pkhr-mi		g/mi
Snowmobiles	5.64	1483		5.64
Snowcoaches	11.2	146		11.20
Total		1629		5.90
E- Factor (g/mi) @				
Vehicle Type	15 mph	g/pkhr-mi		g/mi
Snowmobiles	2.8	736		2.80
Snowcoaches	8.6	112		8.60
Total		848		3.07
E- Factor (g/hr) @				
Vehicle Type	Idle	g/pkhr-mi		g/hr
Snowmobiles	0.93	245		0.93
Snowcoaches	4.4	57		4.40
Total		302		1.09

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	587	63	0.15	0.11
Flagg Ranch	320	21	0.07	0.05

West Entrance/West Entrance to Madison				
Vehicle Type	Vehicles/day	% Vehicles/Peak		# vehs / pk hr
		Hour		
Snowmobiles	400	65.8%		263
Snowcoaches	34	39.3%		13
Total				276
E- Factor (g/mi) @				
Vehicle Type	35 mph	g/pkhr-mi		g/mi
Snowmobiles	0.031	8		0.03
Snowcoaches	0.05	1		0.05
Total		9		0.03
E- Factor (g/mi) @				
Vehicle Type	15 mph	g/pkhr-mi		g/mi
Snowmobiles	0.065	17		0.07
Snowcoaches	0.06	1		0.06
Total		18		0.06
E- Factor (g/hr) @				
Vehicle Type	Idle	g/pkhr-mi		g/hr
Snowmobiles	0.49	129		0.49
Snowcoaches	0.11	1		0.11
Total		130		0.47

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	587	63	0.05	0.040
Flagg Ranch	320	21	0.03	0.0218

Alternative 1b

CO Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/veh-mi)	35 mph (g/veh-mi)	Idle (g/hr)		
Snowmobile	2-Stroke	220.6	242.9	266	0.0083	West Entrance
Snowmobile	Phase 1 2-Stroke	80.4	52.5	266	0.0833	Old Faithful/Flagg Ranch
Snowmobile	Current BAT	35.1	22.9	191.5		
Snowcoach	BAT	17.4	38.7	43.7		

Link	Distance (mi)	Snowmobile Unit Emissions (g/veh link)	Snowcoach Unit Emissions (g/veh-link)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	14.9	7.0	13.95	0.52	14.47
Mammoth to Norris	21	480.9	812.7	75.08	45.63	120.71
West Entrance to Madison	14	320.6	541.8	552.22	86.45	638.67
Madison to Norris	14	320.6	541.8	222.19	45.09	267.27
Norris to Canyon Village	12	274.8	464.4	135.92	24.52	160.44
Canyon Village to Fishing Bridge	16	366.4	619.2	226.43	31.60	258.03
Fishing Bridge to East Entrance	27	618.3	1044.9	30.07	3.66	33.73
Fishing Bridge to West Thumb	21	480.9	812.7	175.92	17.97	193.89
Madison to Old Faithful	16	366.4	619.2	615.10	108.84	723.94
Old Faithful to West Thumb	17	389.3	657.9	408.23	73.59	481.82
West Thumb to Flagg Ranch	24	549.6	928.8	601.41	94.80	696.22
GTNP CDST	24	549.6	928.8	121.06	0.00	121.06
GTNP Grassy	7	160.3	270.9	71.46	0.00	71.46
GTNP Jackson Lake	37.3	854.17	1443.51	150.51	0.00	150.51
Old Faithful Staging Area	NA	15.96	3.64	21.76	0.52	22.29
Flagg Ranch Staging Area	NA	15.96	3.64	12.51	0.19	12.70
Total				3433.83	533.38	3967.21

HC Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	179.9	78.7	473	0.0083	West Entrance
Snowmobile	Phase 1 2-Stroke	18.8	15.5	235.3	0.0833	Old Faithful/Flagg Ranch
Snowmobile	Current BAT	2.82	2.32	35.3		
Snowcoach	BAT	1.6	1	12		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.4	0.7	1.28	0.05	1.33
Mammoth to Norris	21	48.72	21	7.61	1.18	8.79
West Entrance to Madison	14	32.48	14	55.95	2.23	58.18
Madison to Norris	14	32.48	14	22.51	1.17	23.67
Norris to Canyon Village	12	27.84	12	13.77	0.63	14.40
Canyon Village to Fishing Bridge	16	37.12	16	22.94	0.82	23.76
Fishing Bridge to East Entrance	27	62.64	27	3.05	0.09	3.14
Fishing Bridge to West Thumb	21	48.72	21	17.82	0.46	18.29
Madison to Old Faithful	16	37.12	16	62.32	2.81	65.13
Old Faithful to West Thumb	17	39.44	17	41.36	1.90	43.26
West Thumb to Flagg Ranch	24	55.68	24	60.93	2.45	63.38
GTNP CDST	24	55.68	24	12.26	0.00	12.26
GTNP Grassy	7	16.24	7	17.75	0.00	17.75
GTNP Jackson Lake	37.3	86.536	37.3	15.25	0.0	15.25
Old Faithful Staging Area	NA	2.94	1.00	4	0	4
Flagg Ranch Staging Area	NA	2.94	1.00	2	0	2
Total				361.10	14.00	375.10

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Peak Hour	# vehs / pk hr
Snowmobiles	424	65.8%	279
Snowcoaches	34	39.3%	13
Total pk hr			292

E- Factor (g/mi)			
Vehicle Type	@ 35 mph	g/pkhr-mi	g/mi
Snowmobiles	22.9	6389	22.90
Snowcoaches	38.7	503	38.70
Total		6892	23.60

E- Factor (g/mi)			
Vehicle Type	@ 15 mph	g/pkhr-mi	g/mi
Snowmobiles	35.1	9793	35.10
Snowcoaches	17.4	226	17.40
Total		10019	34.31

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	191.5	53429	191.50
Snowcoaches	43.7	568	43.70
Total		53997	184.92

West Entrance South Lane Traffic:	194.7
West Entrance North Lane Traffic:	97.3

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	619	65	22.29	16.71
Flagg Ranch	356	23.17	12.70	9.52

Alternative 1b continued

NOx Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	0.2	0.23	0.53	0.0083	West Entrance
Snowmobile	Current BAT	2.8	5.64	0.93	0.0833	Old Faithful/Flagg Ranch
Snowcoach	BAT	8.6	11.2	4.4		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.1	3.3	1.00	0.25	1.25
Mammoth to Norris	21	118.44	235.2	18.49	13.21	31.70
West Entrance to Madison	14	78.96	156.8	136.01	25.02	161.02
Madison to Norris	14	78.96	156.8	54.72	13.05	67.77
Norris to Canyon Village	12	67.68	134.4	33.48	7.10	40.57
Canyon Village to Fishing Bridge	16	90.24	179.2	55.77	9.15	64.91
Fishing Bridge to East Entrance	27	152.28	302.4	7.41	1.06	8.47
Fishing Bridge to West Thumb	21	118.44	235.2	43.33	5.20	48.53
Madison to Old Faithful	16	90.24	179.2	151.49	31.50	182.99
Old Faithful to West Thumb	17	95.88	190.4	100.54	21.30	121.84
West Thumb to Flagg Ranch	24	135.36	268.8	148.12	27.44	175.56
GTNP CDST	24	135.36	268.8	29.81	0.00	29.81
GTNP Grassy	7	39.48	78.4	5.09	0.00	5.09
GTNP Jackson Lake	37.3	210.372	417.76	37.07	0.00	37.07
Old Faithful Staging Area	NA	0.08	0.37	0	0	0
Flagg Ranch Staging Area	NA	0.08	0.37	0	0	0
Total				822.49	154.32	976.82

PM Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	3.86	1.02	3.77	0.0083	West Entrance
Snowmobile	Current BAT	0.065	0.031	0.49	0.0833	Old Faithful/Flagg Ranch
Snowcoach	BAT	0.06	0.05	0.11		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.0	0.0	0.03	0.00	0.03
Mammoth to Norris	21	0.651	1.05	0.10	0.06	0.16
West Entrance to Madison	14	0.434	0.7	0.75	0.11	0.86
Madison to Norris	14	0.434	0.7	0.30	0.06	0.36
Norris to Canyon Village	12	0.372	0.6	0.18	0.03	0.22
Canyon Village to Fishing Bridge	16	0.496	0.8	0.31	0.04	0.35
Fishing Bridge to East Entrance	27	0.837	1.35	0.04	0.00	0.05
Fishing Bridge to West Thumb	21	0.651	1.05	0.24	0.02	0.26
Madison to Old Faithful	16	0.496	0.8	0.83	0.14	0.97
Old Faithful to West Thumb	17	0.527	0.85	0.55	0.10	0.65
West Thumb to Flagg Ranch	24	0.744	1.2	0.81	0.12	0.94
GTNP CDST	24	0.744	1.2	0.16	0.00	0.16
GTNP Grassy	7	0.217	0.35	0.62	0.00	0.62
GTNP Jackson Lake	37.3	1.1563	1.865	0.20	0.00	0.20
Old Faithful Staging Area	NA	0.041	0.01	0.06	0.00	0.058
Flagg Ranch Staging Area	NA	0.041	0.01	0.03	0.00	0.03
Total				5.23	0.69	5.92

West Entrance/West Entrance to Madison			
% Vehicles/Peak			
Vehicle Type	Vehicles/day	Hour	# vehs / pk hr
Snowmobiles	424	65.8%	279
Snowcoaches	34	39.3%	13
Total pk hr			292
E- Factor (g/mi)			
Vehicle Type	@ 35 mph	g/pkhr-mi	g/mi
Snowmobiles	5.64	1574	5.64
Snowcoaches	11.2	146	11.20
Total	1719		5.89
E- Factor (g/mi)			
Vehicle Type	@ 15 mph	g/pkhr-mi	g/mi
Snowmobiles	2.8	781	2.80
Snowcoaches	8.6	112	8.60
Total	893		3.06
E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	0.93	259	0.93
Snowcoaches	4.4	57	4.40
Total	317		1.08

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	619	65	0.16	0.12
Flagg Ranch	356	23	0.08	0.06

West Entrance/West Entrance to Madison			
% Vehicles/Peak			
Vehicle Type	Vehicles/day	Hour	# vehs / pk hr
Snowmobiles	424	65.8%	279
Snowcoaches	34	39.3%	13
Total pk hr			292
E- Factor (g/mi)			
Vehicle Type	@ 35 mph	g/pkhr-mi	g/mi
Snowmobiles	0.031	9	0.03
Snowcoaches	0.05	1	0.05
Total	9		0.03
E- Factor (g/mi)			
Vehicle Type	@ 15 mph	g/pkhr-mi	g/mi
Snowmobiles	0.065	18	0.07
Snowcoaches	0.06	1	0.06
Total	19		0.06
E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	0.49	137	0.49
Snowcoaches	0.11	1	0.11
Total	138		0.47

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	619	65	0.06	0.044
Flagg Ranch	356	23	0.03	0.0244

Alternative 1d

CO Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/veh-mi)	35 mph (g/veh-mi)	Idle (g/hr)		
Snowmobile	2-Stroke	220.6	242.9	266	0.0083	West Entrance
Snowmobile	Phase 1 2-Stroke	80.4	52.5	266	0.0833	Old Faithful/Flagg Ranch
Snowmobile	Current BAT	35.1	22.9	191.5		
Snowcoach	BAT	17.4	38.7	43.7		

Link	Distance (mi)	Snowmobile Unit Emissions (g/veh link)	Snowcoach Unit Emissions (g/veh-link)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	14.9	7.0	13.16	0.52	13.68
Mammoth to Norris	21	480.9	812.7	94.91	45.63	140.54
West Entrance to Madison	14	320.6	541.8	522.56	86.45	609.01
Madison to Norris	14	320.6	541.8	225.69	45.09	270.78
Norris to Canyon Village	12	274.8	464.4	136.07	24.52	160.59
Canyon Village to Fishing Bridge	16	366.4	619.2	215.32	31.60	246.92
Fishing Bridge to East Entrance	27	618.3	1044.9	27.51	3.66	31.17
Fishing Bridge to West Thumb	21	480.9	812.7	163.97	17.97	181.94
Madison to Old Faithful	16	366.4	619.2	591.89	108.84	700.73
Old Faithful to West Thumb	17	389.3	657.9	367.86	73.59	441.45
West Thumb to Flagg Ranch	24	549.6	928.8	520.55	94.80	615.35
GTNP CDST	24	549.6	928.8	121.06	0.00	121.06
GTNP Grassy	7	160.3	270.9	71.46	0.00	71.46
GTNP Jackson Lake	37.3	854.17	1443.51	150.51	0.00	150.51
Old Faithful Staging Area	NA	15.96	3.64	20.43	0.52	20.95
Flagg Ranch Staging Area	NA	15.96	3.64	11.25	0.19	11.43
Total				3254.20	533.38	3787.58

HC Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	179.9	78.7	473	0.0083	West Entrance
Snowmobile	Phase 1 2-Stroke	18.8	15.5	235.3	0.0833	Old Faithful/Flagg Ranch
Snowmobile	Current BAT	2.82	2.32	35.3		
Snowcoach	BAT	1.6	1	12		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.4	0.7	1.20	0.05	1.26
Mammoth to Norris	21	48.72	21	9.62	1.18	10.79
West Entrance to Madison	14	32.48	14	52.94	2.23	55.17
Madison to Norris	14	32.48	14	22.86	1.17	24.03
Norris to Canyon Village	12	27.84	12	13.79	0.63	14.42
Canyon Village to Fishing Bridge	16	37.12	16	21.81	0.82	22.63
Fishing Bridge to East Entrance	27	62.64	27	2.79	0.09	2.88
Fishing Bridge to West Thumb	21	48.72	21	16.61	0.46	17.08
Madison to Old Faithful	16	37.12	16	59.96	2.81	62.78
Old Faithful to West Thumb	17	39.44	17	37.27	1.90	39.17
West Thumb to Flagg Ranch	24	55.68	24	52.74	2.45	55.19
GTNP CDST	24	55.68	24	12.26	0.00	12.26
GTNP Grassy	7	16.24	7	17.75	0.00	17.75
GTNP Jackson Lake	37.3	86.536	37.3	15.25	0.0	15.25
Old Faithful Staging Area	NA	2.94	1.00	3.77	0.14	3.91
Flagg Ranch Staging Area	NA	2.94	1.00	2.07	0.05	2.12
Total				342.70	14.00	356.70

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Peak Hour	# vehs / pk hr
Snowmobiles	400	65.8%	263
Snowcoaches	34	39.3%	13
		Total pk hr	276

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	22.9	6023	22.90
Snowcoaches	38.7	503	38.70
Total		6526	23.64

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	35.1	9231	35.10
Snowcoaches	17.4	226	17.40
Total		9458	34.27

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	191.5	50365	191.50
Snowcoaches	43.7	568	43.70
Total		50933	184.54

West Entrance South Lane Traffic: 184.0
West Entrance North Lane Traffic: 92.0

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	581.2	65.29	20.95	15.71
Flagg Ranch	320	23.17	11.43	8.58

Alternative 1d continued

NOx Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	0.2	0.23	0.53	0.0083
Snowmobile	Current BAT	2.8	5.64	0.93	0.0833
Snowcoach	BAT	8.6	11.2	4.4	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.1	3.3	0.94	0.25	1.19
Mammoth to Norris	21	118.44	235.2	23.37	13.21	36.58
West Entrance to Madison	14	78.96	156.8	128.70	25.02	153.72
Madison to Norris	14	78.96	156.8	55.59	13.05	68.63
Norris to Canyon Village	12	67.68	134.4	33.51	7.10	40.61
Canyon Village to Fishing Bridge	16	90.24	179.2	53.03	9.15	62.18
Fishing Bridge to East Entrance	27	152.28	302.4	6.78	1.06	7.83
Fishing Bridge to West Thumb	21	118.44	235.2	40.38	5.20	45.59
Madison to Old Faithful	16	90.24	179.2	145.78	31.50	177.27
Old Faithful to West Thumb	17	95.88	190.4	90.60	21.30	111.90
West Thumb to Flagg Ranch	24	135.36	268.8	128.20	27.44	155.64
GTNP CDS	24	135.36	268.8	29.81	0.00	29.81
GTNP Grassy	7	39.48	78.4	5.09	0.00	5.09
GTNP Jackson Lake	37.3	210.37	417.76	37.07	0.00	37.07
Old Faithful Staging Area	NA	0.0775	0.37	0.10	0.05	0.15
Flagg Ranch Staging Area	NA	0.0775	0.37	0.05	0.02	0.07
Total				779.02	154.32	933.34

PM Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	3.86	1.02	3.77	0.0083
Snowmobile	Current BAT	0.065	0.031	0.49	0.0833
Snowcoach	BAT	0.06	0.05	0.11	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.0	0.0	0.03	0.00	0.03
Mammoth to Norris	21	0.651	1.05	0.13	0.06	0.19
West Entrance to Madison	14	0.434	0.7	0.71	0.11	0.82
Madison to Norris	14	0.434	0.7	0.31	0.06	0.36
Norris to Canyon Village	12	0.372	0.6	0.18	0.03	0.22
Canyon Village to Fishing Bridge	16	0.496	0.8	0.29	0.04	0.33
Fishing Bridge to East Entrance	27	0.837	1.35	0.04	0.00	0.04
Fishing Bridge to West Thumb	21	0.651	1.05	0.22	0.02	0.25
Madison to Old Faithful	16	0.496	0.8	0.80	0.14	0.94
Old Faithful to West Thumb	17	0.527	0.85	0.50	0.10	0.59
West Thumb to Flagg Ranch	24	0.744	1.2	0.70	0.12	0.83
GTNP CDS	24	0.744	1.2	0.16	0.00	0.16
GTNP Grassy	7	0.217	0.35	0.62	0.00	0.62
GTNP Jackson Lake	37.3	1.1563	1.865	0.20	0.00	0.20
Old Faithful Staging Area	NA	0.0408	0.0092	0.05	0.00	0.054
Flagg Ranch Staging Area	NA	0.0408	0.0092	0.03	0.00	0.03
Total				4.98	0.69	5.67

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Peak Hour	# vehs / pk hr
Snowmobiles	400	65.8%	263
Snowcoaches	34	39.3%	13
Total pk hr			276
E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	5.64	1483	5.64
Snowcoaches	11.2	146	11.20
Total		1629	5.90
E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	2.8	736	2.80
Snowcoaches	8.6	112	8.60
Total		848	3.07
E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	0.93	245	0.93
Snowcoaches	4.4	57	4.40
Total		302	1.09

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	581.2	65.29	0.15	0.11
Flagg Ranch	320	23.17	0.07	0.06

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Peak Hour	# vehs / pk hr
Snowmobiles	400	65.8%	263
Snowcoaches	34	37.0%	13
Total pk hr			276
E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	0.031	8	0.03
Snowcoaches	0.1	1	0.05
Total		9	0.03
E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	0.065	17	0.07
Snowcoaches	0.06	1	0.06
Total		18	0.06
E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	0.49	129	0.49
Snowcoaches	0.11	1	0.11
Total		130	0.47

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	581	65	0.05	0.040
Flagg Ranch	320	23	0.03	0.0219

Alternative 1e

CO Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds				
		15 mph (g/vel-mi)	35 mph (g/vel-mi)	Idle (g/hr)	Idle Time (hr)	
Snowmobile	2-Stroke	222.6	242.9	266	0.0083	West Entrance
Snowmobile	Phase 1 2-Stroke	80.4	52.5	266	0.0833	Old Faithful/Flagg Ranch
Snowmobile	Current BAT	35.1	22.9	191.5		
Snowcoach	BAT	17.4	38.7	43.7		

Link	Distance (mi)	Snowmobile Unit Emissions (g/veh link)	Snowcoach Unit Emissions (g/veh-link)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	14.9	7.0	13.16	0.52	13.68
Mammoth to Norris	21	480.9	812.7	91.73	51.63	143.36
West Entrance to Madison	14	320.6	541.8	530.76	81.34	612.10
Madison to Norris	14	320.6	541.8	0.00	0.00	0.00
Norris to Canyon Village	12	274.8	464.4	41.52	21.52	63.04
Canyon Village to Fishing Bridge	16	366.4	619.2	132.68	54.64	187.32
Fishing Bridge to East Entrance	27	618.3	1044.9	27.51	3.66	31.17
Fishing Bridge to West Thumb	21	480.9	812.7	208.25	62.90	271.15
Madison to Old Faithful	16	366.4	619.2	680.02	102.51	782.53
Old Faithful to West Thumb	17	389.3	657.9	451.47	84.53	536.00
West Thumb to Flagg Ranch	24	549.6	928.8	517.04	55.87	572.91
GTNP CDST	24	549.6	928.8	121.06	0.00	121.06
GTNP Grassy	7	160.3	270.9	71.46	0.00	71.46
GTNP Jackson Lake	37.3	854.17	1443.51	150.51	0.00	150.51
Old Faithful Staging Area	NA	15.96	3.64	24.06	0.54	24.60
Flagg Ranch Staging Area	NA	15.96	3.64	11.25	0.11	11.36
Total				3072.47	519.76	3592.24

HC Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/hr)	35 mph (g/hr)	Idle (g/hr)		
Snowmobile	2-Stroke	179.9	78.7	473	0.0083	West Entrance
Snowmobile	Phase 1 2-Stroke	18.8	15.5	235.3	0.0833	Old Faithful/Flagg Ranch
Snowmobile	Current BAT	2.82	2.32	35.3		
Snowcoach	BAT	1.6	1	12		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.4	0.7	1.20	0.05	1.26
Mammoth to Norris	21	48.72	21	9.29	1.33	10.63
West Entrance to Madison	14	32.48	14	53.77	2.10	55.87
Madison to Norris	14	32.48	14	0.00	0.00	0.00
Norris to Canyon Village	12	27.84	12	4.21	0.56	4.76
Canyon Village to Fishing Bridge	16	37.12	16	13.44	1.41	14.85
Fishing Bridge to East Entrance	27	62.64	27	2.79	0.09	2.88
Fishing Bridge to West Thumb	21	48.72	21	21.10	1.63	22.72
Madison to Old Faithful	16	37.12	16	68.89	2.65	71.54
Old Faithful to West Thumb	17	39.44	17	45.74	2.18	47.92
West Thumb to Flagg Ranch	24	55.68	24	52.38	1.44	53.82
GTNP CDST	24	55.68	24	12.26	0.00	12.26
GTNP Grassy	7	16.24	7	17.75	0.00	17.75
GTNP Jackson Lake	37.3	86.536	37.3	15.25	0.0	15.25
Old Faithful Staging Area	NA	2.94	1.00	4.44	0.15	4.58
Flagg Ranch Staging Area	NA	2.94	1.00	2.07	0.03	2.10
Total				324.59	13.63	338.22

West Entrance/West Entrance to Madison			
		% Vehicles/Peak	
Vehicle Type	Vehicles/day	Hour	# vehs / pk hr
Snowmobiles	400	65.8%	263
Snowcoaches	34	39.3%	13
		Total pk hr	276

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	22.9	6023	22.90
Snowcoaches	38.7	503	38.70
Total		6526	23.64

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	35.1	9231	35.10
Snowcoaches	17.4	226	17.40
Total		9458	34.27

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	191.5	50365	191.50
Snowcoaches	43.7	568	43.70
Total		50933	184.54

West Entrance South Lane Traffic:	184.0
West Entrance North Lane Traffic:	92.0

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	685	67	24.60	18.45
Flagg Ranch	320	13.655	11.36	8.52

Alternative 1e continued

NOx Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	0.2	0.23	0.53	0.0083
Snowmobile	Current BAT	2.8	5.64	0.93	0.0833
Snowcoach	BAT	8.6	11.2	4.4	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.1	3.3	0.94	0.25	1.19
Mammoth to Norris	21	118.44	235.2	22.59	14.94	37.53
West Entrance to Madison	14	78.96	156.8	130.72	23.54	154.26
Madison to Norris	14	78.96	156.8	0.00	0.00	0.00
Norris to Canyon Village	12	67.68	134.4	10.23	6.23	16.46
Canyon Village to Fishing Bridge	16	90.24	179.2	32.68	15.81	48.49
Fishing Bridge to East Entrance	27	152.28	302.4	6.78	1.06	7.83
Fishing Bridge to West Thumb	21	118.44	235.2	51.29	18.20	69.49
Madison to Old Faithful	16	90.24	179.2	167.48	29.67	197.15
Old Faithful to West Thumb	17	95.88	190.4	111.19	24.46	135.65
West Thumb to Flagg Ranch	24	135.36	268.8	127.34	16.17	143.51
GTNP CDST	24	135.36	268.8	29.81	0.00	29.81
GTNP Grassy	7	39.48	78.4	5.09	0.00	5.09
GTNP Jackson Lake	37.3	210.372	417.76	37.07	0.00	37.07
Old Faithful Staging Area	NA	0.0775	0.37	0.12	0.05	0.17
Flagg Ranch Staging Area	NA	0.0775	0.37	0.05	0.01	0.07
Total				733.38	150.40	883.78

PM Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	3.86	1.02	3.77	0.0083
Snowmobile	Current BAT	0.065	0.031	0.49	0.0833
Snowcoach	BAT	0.06	0.05	0.11	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.0	0.0	0.03	0.00	0.03
Mammoth to Norris	21	0.651	1.05	0.12	0.07	0.19
West Entrance to Madison	14	0.434	0.7	0.72	0.11	0.82
Madison to Norris	14	0.434	0.7	0.00	0.00	0.00
Norris to Canyon Village	12	0.372	0.6	0.06	0.03	0.08
Canyon Village to Fishing Bridge	16	0.496	0.8	0.18	0.07	0.25
Fishing Bridge to East Entrance	27	0.837	1.35	0.04	0.00	0.04
Fishing Bridge to West Thumb	21	0.651	1.05	0.28	0.08	0.36
Madison to Old Faithful	16	0.496	0.8	0.92	0.13	1.05
Old Faithful to West Thumb	17	0.527	0.85	0.61	0.11	0.72
West Thumb to Flagg Ranch	24	0.744	1.2	0.70	0.07	0.77
GTNP CDST	24	0.744	1.2	0.16	0.00	0.16
GTNP Grassy	7	0.217	0.35	0.62	0.00	0.62
GTNP Jackson Lake	37.3	1.1563	1.865	0.20	0.00	0.20
Old Faithful Staging Area	NA	0.041	0.0092	0.06	0.00	0.06
Flagg Ranch Staging Area	NA	0.041	0.0092	0.03	0.00	0.03
Total				4.74	0.67	5.41

West Entrance/West Entrance to Madison			
		% Vehicles/Peak	
Vehicle Type	Vehicles/day	Hour	# vehs / pk hr
Snowmobiles	400	65.8%	263
Snowcoaches	34	39.3%	13
Total pk hr			276

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	5.64	1483	5.64
Snowcoaches	11.2	146	11.20
Total		1629	5.90

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	2.8	736	2.80
Snowcoaches	8.6	112	8.60
Total		848	3.07

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	0.93	245	0.93
Snowcoaches	4.4	57	4.40
Total		302	1.09

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	685	67	0.17	0.13
Flagg Ranch	320	14	0.07	0.05

West Entrance/West Entrance to Madison			
		% Vehicles/Peak	
Vehicle Type	Vehicles/day	Hour	# vehs / pk hr
Snowmobiles	400	65.8%	263
Snowcoaches	34	39.3%	13
Total pk hr			276

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	0.031	8	0.03
Snowcoaches	0.05	1	0.05
Total		9	0.03

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	0.065	17	0.07
Snowcoaches	0.06	1	0.06
Total		18	0.06

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	0.49	129	0.49
Snowcoaches	0.11	1	0.11
Total		130	0.47

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	685	67	0.06	0.047
Flagg Ranch	320	14	0.03	0.0218

Alternative 2

CO Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	220.6	242.9	266	0.0083	West Entrance
Snowmobile	Phase 1 2-Stroke	80.4	52.5	266	0.0833	Old Faithful/Flagg Ranch
Snowmobile	Current BAT	35.1	22.9	191.5		
Snowcoach	BAT	17.4	38.7	43.7		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	14.9	7.0	0.00	0.85	0.85
Mammoth to Norris	21	480.9	812.7	0.00	61.04	61.04
West Entrance to Madison	14	320.6	541.8	0.00	135.86	135.86
Madison to Norris	14	320.6	541.8	0.00	67.10	67.10
Norris to Canyon Village	12	274.8	464.4	0.00	37.18	37.18
Canyon Village to Fishing Bridge	16	366.4	619.2	0.00	51.08	51.08
Fishing Bridge to East Entrance	27	618.3	1044.9	0.00	6.19	6.19
Fishing Bridge to West Thumb	21	480.9	812.7	0.00	31.54	31.54
Madison to Old Faithful	16	366.4	619.2	0.00	167.28	167.28
Old Faithful to West Thumb	17	389.3	657.9	0.00	114.99	114.99
West Thumb to Flagg Ranch	24	549.6	928.8	0.00	152.39	152.39
GTNP CDST	24	549.6	928.8	0.00	0.00	0.00
GTNP Grassy	7	160.3	270.9	0.00	0.00	0.00
GTNP Jackson Lake	37.3	854.17	1443.51	0.00	0.00	0.00
Old Faithful Staging Area	NA	15.96	3.64	0.00	0.81	0.81
Flagg Ranch Staging Area	NA	15.96	3.64	0.00	0.30	0.30
Total				0.00	826.61	826.61

HC Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	179.9	78.7	473	0.0083	West Entrance
Snowmobile	Phase 1 2-Stroke	18.8	15.5	235.3	0.0833	Old Faithful/Flagg Ranch
Snowmobile	Current BAT	2.82	2.32	35.3		
Snowcoach	BAT	1.6	1.0	12.0		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.4	0.7	0.00	0.09	0.09
Mammoth to Norris	21	48.72	21	0.00	1.58	1.58
West Entrance to Madison	14	32.48	14	0.00	3.51	3.51
Madison to Norris	14	32.48	14	0.00	1.73	1.73
Norris to Canyon Village	12	27.84	12	0.00	0.96	0.96
Canyon Village to Fishing Bridge	16	37.12	16	0.00	1.32	1.32
Fishing Bridge to East Entrance	27	62.64	27	0.00	0.16	0.16
Fishing Bridge to West Thumb	21	48.72	21	0.00	0.82	0.82
Madison to Old Faithful	16	37.12	16	0.00	4.32	4.32
Old Faithful to West Thumb	17	39.44	17	0.00	2.97	2.97
West Thumb to Flagg Ranch	24	55.68	24	0.00	3.94	3.94
GTNP CDST	24	55.68	24	0.00	0.00	0.00
GTNP Grassy	7	16.24	7	0.00	0.00	0.00
GTNP Jackson Lake	37.3	86.536	37.3	0.00	0.00	0.00
Old Faithful Staging Area	NA	2.94	1.00	0.00	0.22	0.22
Flagg Ranch Staging Area	NA	2.94	1.00	0.00	0.08	0.08
Total				0.00	21.70	21.70

West Entrance/West Entrance to Madison			
		% Vehicles/Peak	
Vehicle Type	Vehicles/day	Hour	# vehs / pk hr
Snowmobiles	0	65.8%	0
Snowcoaches	55	39.3%	22
		Total pk hr	22

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	22.9	0	0.00
Snowcoaches	38.7	851	38.70
Total		851	38.70

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	35.1	0	0.00
Snowcoaches	17.4	383	17.40
Total		383	17.40

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	191.5	0	0.00
Snowcoaches	43.7	961	43.70
Total		961	43.70

West Entrance South Lane Traffic: 14.7
West Entrance North Lane Traffic: 7.3

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	0	101	0.81	0.61
Flagg Ranch	0	37.245	0.30	0.22

Alternative 2 continued

NOx Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	0.2	0.23	0.53	0.0083
Snowmobile	Current BAT	2.8	5.64	0.93	0.0833
Snowcoach	BAT	8.6	11.2	4.4	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.1	3.3	0.00	0.40	0.40
Mammoth to Norris	21	118.44	235.2	0.00	17.67	17.67
West Entrance to Madison	14	78.96	156.8	0.00	39.32	39.32
Madison to Norris	14	78.96	156.8	0.00	19.42	19.42
Norris to Canyon Village	12	67.68	134.4	0.00	10.76	10.76
Canyon Village to Fishing Bridge	16	90.24	179.2	0.00	14.78	14.78
Fishing Bridge to East Entrance	27	152.28	302.4	0.00	1.79	1.79
Fishing Bridge to West Thumb	21	118.44	235.2	0.00	9.13	9.13
Madison to Old Faithful	16	90.24	179.2	0.00	48.41	48.41
Old Faithful to West Thumb	17	95.88	190.4	0.00	33.28	33.28
West Thumb to Flagg Ranch	24	135.36	268.8	0.00	44.10	44.10
GTNP CDST	24	135.36	268.8	0.00	0.00	0.00
GTNP Grassy	7	39.48	78.4	0.00	0.00	0.00
GTNP Jackson Lake	37.3	210.37	417.76	0.00	0.00	0.00
Old Faithful Staging Area	NA	0.0775	0.37	0.00	0.05	0.05
Flagg Ranch Staging Area	NA	0.0775	0.37	0.00	0.02	0.02
Total				0.00	239.13	239.13

PM Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	3.86	1.02	3.77	0.0083
Snowmobile	Current BAT	0.065	0.031	0.49	0.0833
Snowcoach	BAT	0.06	0.05	0.11	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.0	0.0	0.00	0.00	0.00
Mammoth to Norris	21	0.651	1.05	0.00	0.06	0.06
West Entrance to Madison	14	0.434	0.7	0.00	0.11	0.11
Madison to Norris	14	0.434	0.7	0.00	0.06	0.06
Norris to Canyon Village	12	0.372	0.6	0.00	0.03	0.03
Canyon Village to Fishing Bridge	16	0.496	0.8	0.00	0.04	0.04
Fishing Bridge to East Entrance	27	0.837	1.35	0.00	0.00	0.00
Fishing Bridge to West Thumb	21	0.651	1.05	0.00	0.02	0.02
Madison to Old Faithful	16	0.496	0.8	0.00	0.14	0.14
Old Faithful to West Thumb	17	0.527	0.85	0.00	0.10	0.10
West Thumb to Flagg Ranch	24	0.744	1.2	0.00	0.12	0.12
GTNP CDST	24	0.744	1.2	0.00	0.00	0.00
GTNP Grassy	7	0.217	0.35	0.00	0.00	0.00
GTNP Jackson Lake	37.3	1.1563	1.865	0.00	0.00	0.00
Old Faithful Staging Area	NA	0.040833333	0.009	0.00	0.00	0.00
Flagg Ranch Staging Area	NA	0.040833333	0.009	0.00	0.00	0.00
Total				0.00	0.69	0.69

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Peak	
		Hour	# vehs / pk hr
Snowmobiles	0	65.8%	0
Snowcoaches	55	39.3%	22
		Total pk hr	22
E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	5.64	0	0.00
Snowcoaches	11.2	246	11.20
Total		246	11.20
E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	2.8	0	0.00
Snowcoaches	8.6	189	8.60
Total		189	8.60
E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	0.93	0	0.00
Snowcoaches	4.4	97	4.40
Total		97	4.40

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	0	101	0.05	0.04
Flagg Ranch	0	37	0.03	0.0226

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Peak	
		Hour	# vehs / pk hr
Snowmobiles	0	65.8%	0
Snowcoaches	55	39.3%	22
		Total pk hr	
		22	
E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	0.031	0	0.00
Snowcoaches	0.05	1	0.05
Total		1	0.05
E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	0.065	0	0.00
Snowcoaches	0.06	1	0.06
Total		1	0.06
E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	0.49	0	0.00
Snowcoaches	0.11	2	0.11
Total		2	0.11

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	0	101	0.00	0.001
Flagg Ranch	0	37	0.00	0.0006

Alternative 3

CO Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	220.6	242.9	266	0.0083	West Entrance
Snowmobile	Phase 1 2-Stroke	80.4	52.5	266	0.083	Old Faithful/Flagg Ranch
Snowmobile	Current BAT	35.1	22.9	191.5		
Snowcoach	BAT	17.4	38.7	43.7		

No traffic on West Entrance or from West Entrance to Madison; therefore, composite emissions are zero.

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	14.9	7.0	0.00	0.00	0.00
Mammoth to Norris	21	480.9	812.7	0.00	0.00	0.00
West Entrance to Madison	14	320.6	541.8	0.00	0.00	0.00
Madison to Norris	14	320.6	541.8	0.00	0.00	0.00
Norris to Canyon Village	12	274.8	464.4	0.00	0.00	0.00
Canyon Village to Fishing Bridge	16	366.4	619.2	0.00	0.00	0.00
Fishing Bridge to East Entrance	27	618.3	1044.9	0.00	0.00	0.00
Fishing Bridge to West Thumb	21	480.9	812.7	0.00	0.00	0.00
Madison to Old Faithful	16	366.4	619.2	0.00	0.00	0.00
Old Faithful to West Thumb	17	389.3	657.9	428.74	57.96	486.71
West Thumb to Flagg Ranch	24	549.6	928.8	605.29	81.83	687.12
GTNP CDST	24	549.6	928.8	0.00	0.00	0.00
GTNP Grassy	7	160.3	270.9	73.23	0.00	73.23
GTNP Jackson Lake	37.3	854.17	1443.51	0.00	0.00	0.00
Old Faithful Staging Area	NA	15.89	3.63	8.75	0.16	8.91
Flagg Ranch Staging Area	NA	15.89	3.63	10.50	0.16	10.66
Total				1126.51	140.12	1266.63

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	250	20	8.91	6.68
Flagg Ranch	300	20	10.66	8.00

HC Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	179.9	78.7	473	0.0083	West Entrance
Snowmobile	Phase 1 2-Stroke	18.8	15.5	235.3	0.083	Old Faithful/Flagg Ranch
Snowmobile	Current BAT	2.82	2.32	35.3		
Snowcoach	BAT	1.6	1	12		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.4	0.7	0.00	0.00	0.00
Mammoth to Norris	21	48.72	21	0.00	0.00	0.00
West Entrance to Madison	14	32.48	14	0.00	0.00	0.00
Madison to Norris	14	32.48	14	0.00	0.00	0.00
Norris to Canyon Village	12	27.84	12	0.00	0.00	0.00
Canyon Village to Fishing Bridge	16	37.12	16	0.00	0.00	0.00
Fishing Bridge to East Entrance	27	62.64	27	0.00	0.00	0.00
Fishing Bridge to West Thumb	21	48.72	21	0.00	0.00	0.00
Madison to Old Faithful	16	37.12	16	0.00	0.00	0.00
Old Faithful to West Thumb	17	39.44	17	43.44	1.50	44.93
West Thumb to Flagg Ranch	24	55.68	24	61.32	2.11	63.44
GTNP CDST	24	55.68	24	0.00	0.00	0.00
GTNP Grassy	7	16.24	7	14.36	0.00	14.36
GTNP Jackson Lake	37.3	86.54	37.30	0.00	0.00	0.00
Old Faithful Staging Area	NA	2.93	1.00	1.61	0.04	1.66
Flagg Ranch Staging Area	NA	2.93	1.00	1.94	0.04	1.98
Total				122.66	3.70	126.36

Alternative 3 continued

NOx Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	0.2	0.23	0.53	0.0083
Snowmobile	Current BAT	2.8	5.64	0.93	0.083
Snowcoach	BAT	8.6	11.2	4.4	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.1	3.3	0.00	0.00	0.00
Mammoth to Norris	21	118.44	235.2	0.00	0.00	0.00
West Entrance to Madison	14	78.96	156.8	0.00	0.00	0.00
Madison to Norris	14	78.96	156.8	0.00	0.00	0.00
Norris to Canyon Village	12	67.68	134.4	0.00	0.00	0.00
Canyon Village to Fishing Bridge	16	90.24	179.2	0.00	0.00	0.00
Fishing Bridge to East Entrance	27	152.28	302.4	0.00	0.00	0.00
Fishing Bridge to West Thumb	21	118.44	235.2	0.00	0.00	0.00
Madison to Old Faithful	16	90.24	179.2	0.00	0.00	0.00
Old Faithful to West Thumb	17	95.88	190.4	105.59	16.78	122.37
West Thumb to Flagg Ranch	24	135.36	268.8	149.07	23.68	172.76
GTNP CDST	24	135.36	268.8	0.00	0.00	0.00
GTNP Grassy	7	39.48	78.4	5.53	0.00	5.53
GTNP Jackson Lake	37.3	210.372	417.76	0.00	0.00	0.00
Old Faithful Staging Area	NA	0.08	0.37	0.04	0.02	0.06
Flagg Ranch Staging Area	NA	0.08	0.37	0.05	0.02	0.07
Total				260.29	40.49	300.78

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	250	20	0.06	0.044
Flagg Ranch	300	20	0.07	0.05

PM Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	3.86	1.02	3.77	0.0083
Snowmobile	Current BAT	0.065	0.031	0.49	0.083
Snowcoach	BAT	0.06	0.05	0.11	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.0	0.0	0.00	0.00	0.00
Mammoth to Norris	21	0.651	1.05	0.00	0.00	0.00
West Entrance to Madison	14	0.434	0.7	0.00	0.00	0.00
Madison to Norris	14	0.434	0.7	0.00	0.00	0.00
Norris to Canyon Village	12	0.372	0.6	0.00	0.00	0.00
Canyon Village to Fishing Bridge	16	0.496	0.8	0.00	0.00	0.00
Fishing Bridge to East Entrance	27	0.837	1.35	0.00	0.00	0.00
Fishing Bridge to West Thumb	21	0.651	1.05	0.00	0.00	0.00
Madison to Old Faithful	16	0.496	0.8	0.00	0.00	0.00
Old Faithful to West Thumb	17	0.527	0.85	0.58	0.07	0.66
West Thumb to Flagg Ranch	24	0.744	1.2	0.82	0.11	0.93
GTNP CDST	24	0.744	1.2	0.00	0.00	0.00
GTNP Grassy	7	0.217	0.35	0.63	0.00	0.63
GTNP Jackson Lake	37.3	1.1563	1.865	0.00	0.00	0.00
Old Faithful Staging Area	NA	0.04	0.01	0.00	0.00	0.00
Flagg Ranch Staging Area	NA	0.04	0.01	0.03	0.00	0.03
Total				2.05	0.18	2.24

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	581.2	65.29	0.00	0.0003
Flagg Ranch	300	20	0.03	0.0205

Alternative 4

Yellowstone snowmobiles 100% BAT

All Grassy Lake snowmobiles exempt from BAT; assume EPA reg Phase 1, assigned at 20% 2-stroke, 70% Phase 1 2-stroke, and 10% BAT.

CDST snowmobiles based on 2/3 BAT; remaining 1/3 based on the 20/70/10 percent mix (EPA reg Phase 1)

CO Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			% Snowmobiles	Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)			
Snowmobile	2-Stroke	220.6	242.9	266	20%	0.0083	West Entrance
Snowmobile	Phase 1 2-Stroke	80.4	52.5	266	70%	0.083	Old Faithful/Flagg Ranch
Snowmobile	Current BAT	35.1	22.9	191.5	10%		
Snowcoach	BAT	17.4	38.7	43.7			

Link	Distance (mi)	Snowmobile Unit Emissions (g)			Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
		2-Stroke	Phase 1 2-Stroke	BAT				
West Entrance	0.38	NA	NA	14.9	7.0	19.73	0.77	20.50
Mammoth to Norris	21	NA	NA	480.9	812.7	113.87	61.17	175.04
West Entrance to Madison	14	NA	NA	320.6	541.8	786.49	125.93	912.42
Madison to Norris	14	NA	NA	320.6	541.8	327.66	63.68	391.34
Norris to Canyon Village	12	NA	NA	274.8	464.4	209.13	35.71	244.84
Canyon Village to Fishing Bridge	16	NA	NA	366.4	619.2	403.93	54.71	458.63
Fishing Bridge to East Entrance	27	NA	NA	618.3	1044.9	253.31	23.68	277.00
Fishing Bridge to West Thumb	21	NA	NA	480.9	812.7	242.04	28.68	270.72
Madison to Old Faithful	16	NA	NA	366.4	619.2	851.23	155.32	1006.55
Old Faithful to West Thumb	17	NA	NA	369.3	657.9	478.69	104.63	583.32
West Thumb to Flagg Ranch	24	NA	NA	549.6	928.8	592.59	133.84	716.43
GTNP CDST	24	5829.6	549.6	549.6	928.8	296.72	0.00	296.72
GTNP Grassy	7	1700.3	367.5	160.3	270.9	155.26	0.00	155.26
GTNP Jackson Lake	37.3	9060.17	854.17	854.17	1443.51	376.29	0.00	376.29
Old Faithful Staging Area	NA	NA	NA	15.89	3.63	28.24	0.74	28.98
Flagg Ranch Staging Area	NA	22.1	22.1	15.89	3.63	25.18	0.26	25.45
Total						5150.36	789.10	5939.46

HC Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			% Snowmobiles	Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)			
Snowmobile	2-Stroke	179.9	78.7	473	20%	0.0083	West Entrance
Snowmobile	Phase 1 2-Stroke	18.8	15.5	235.3	70%	0.083	Old Faithful/Flagg Ranch
Snowmobile	Current BAT	2.82	2.32	35.3	10%		
Snowcoach	BAT	1.6	1	12			

Link	Distance (mi)	Snowmobile Unit Emissions (g)			Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
		2-Stroke	Phase 1 2-Stroke	BAT				
West Entrance	0.38	NA	NA	1.4	0.7	1.80	0.08	1.88
Mammoth to Norris	21	NA	NA	48.72	21	11.54	1.58	13.12
West Entrance to Madison	14	NA	NA	32.48	14	79.68	3.25	82.93
Madison to Norris	14	NA	NA	32.48	14	33.20	1.65	34.84
Norris to Canyon Village	12	NA	NA	27.84	12	21.19	0.92	22.11
Canyon Village to Fishing Bridge	16	NA	NA	37.12	16	40.92	1.41	42.34
Fishing Bridge to East Entrance	27	NA	NA	62.64	27	25.66	0.61	26.28
Fishing Bridge to West Thumb	21	NA	NA	48.72	21	24.52	0.74	25.26
Madison to Old Faithful	16	NA	NA	37.12	16	86.24	4.01	90.25
Old Faithful to West Thumb	17	NA	NA	39.44	17	48.50	2.70	51.20
West Thumb to Flagg Ranch	24	NA	NA	55.68	24	59.02	3.46	62.48
GTNP CDST	24	1888.8	372	55.68	24	82.51	0.00	82.51
GTNP Grassy	7	550.9	108.5	16.24	7	58.93	0.00	58.93
GTNP Jackson Lake	37.3	2935.51	578.15	86.536	37.3	38.12	0.00	38.12
Old Faithful Staging Area	NA	NA	NA	2.93	1.00	5.20	0.20	5
Flagg Ranch Staging Area	NA	NA	NA	2.93	1.00	2.58	0.07	3
Total						619.62	20.70	640.31

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Peak Hour	# vehs / pk hr
Snowmobiles	600	65.8%	395
Snowcoaches	50	39.3%	20
		Total pk hr	415

E- Factor (g/mi) @		
Vehicle Type	35 mph	g/pkhr-mi
Snowmobiles	22.9	9046
Snowcoaches	38.7	774
Total		9820

E- Factor (g/mi) @		
Vehicle Type	15 mph	g/pkhr-mi
Snowmobiles	35.1	13865
Snowcoaches	17.4	348
Total		14213

E- Factor (g/hr) @		
Vehicle Type	Idle	g/pkhr-mi
Snowmobiles	191.5	75643
Snowcoaches	43.7	874
Total		76517

West Entrances South Lane Traffic: 276.7

West Entrance North Lane Traffic: 138.3

# Snowmobiles		Emissions	
Staging Area	YS	# Snowcoaches	Emissions
Old Faithful	807	93	28.98
Flagg Ranch	400	32.71	15.49

Alternative 4 continued

NOx Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	0.2	0.23	0.53	0.0083	West Entrance Old Faithful/Flagg Ranch
Snowmobile	Current BAT	2.8	5.64	0.93	0.083	
Snowcoach	No BAT	14.9	15.2	4.1		
Snowcoach	BAT	8.6	11.2	4.4		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.1	3.3	1.42	0.36	1.78
Mammoth to Norris	21	118.44	235.2	28.04	17.70	45.75
West Entrance to Madison	14	78.96	156.8	193.70	36.44	230.15
Madison to Norris	14	78.96	156.8	80.70	18.43	99.13
Norris to Canyon Village	12	67.68	134.4	51.51	10.33	61.84
Canyon Village to Fishing Bridge	16	90.24	179.2	99.48	15.83	115.31
Fishing Bridge to East Entrance	27	152.28	302.4	62.39	6.85	69.24
Fishing Bridge to West Thumb	21	118.44	235.2	59.61	8.30	67.91
Madison to Old Faithful	16	90.24	179.2	209.65	44.95	254.60
Old Faithful to West Thumb	17	95.88	190.4	117.90	30.28	148.18
West Thumb to Flagg Ranch	24	135.36	269.8	143.48	38.73	182.22
GTNP CDST	24	92.51	268.8	30.57	0.00	30.57
GTNP Grassy	7	26.9829	78.4	8.47	0.00	8.47
GTNP Jackson Lake	37.3	143.78	417.76	63.34	0.00	63.34
Old Faithful Staging Area	NA	0.08	0.37	0.14	0.07	0.21
Flagg Ranch Staging Area	NA	0.08	0.37	0.11	0.03	0.14
Total				1150.50	228.32	1378.83

PM Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	3.86	1.02	3.77	0.0083	West Entrance Old Faithful/Flagg Ranch
Snowmobile	Current BAT	0.065	0.031	0.49	0.083	
Snowmobile	Improved BAT	0.068	0.034	0.54		
Snowcoach	BAT	0.06	0.05	0.11		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.0	0.0	0.04	0.00	0.04
Mammoth to Norris	21	0.651	1.05	0.15	0.08	0.23
West Entrance to Madison	14	0.434	0.7	1.06	0.16	1.23
Madison to Norris	14	0.434	0.7	0.44	0.08	0.53
Norris to Canyon Village	12	0.372	0.6	0.28	0.05	0.33
Canyon Village to Fishing Bridge	16	0.496	0.8	0.55	0.07	0.62
Fishing Bridge to East Entrance	27	0.837	1.35	0.34	0.03	0.37
Fishing Bridge to West Thumb	21	0.651	1.05	0.33	0.04	0.36
Madison to Old Faithful	16	0.496	0.8	1.15	0.20	1.35
Old Faithful to West Thumb	17	0.527	0.85	0.65	0.14	0.78
West Thumb to Flagg Ranch	24	0.744	1.2	0.79	0.17	0.96
GTNP CDST	24	8.57688	1.2	2.83	0.00	2.83
GTNP Grassy	7	2.50159	0.35	0.79	0.00	0.79
GTNP Jackson Lake	37.3	13.33	1.87	5.87	0.00	5.87
Old Faithful Staging Area	NA	0.04	0.01	0.07	0.00	0.07
Flagg Ranch Staging Area	NA	0.04	0.01	0.00	0.00	0.00
Total				15.35	1.02	16.38

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Peak	
		Hour	# vehs / pk hr
Snowmobiles	600	65.8%	395
Snowcoaches	50	39.3%	20
Total pk hr			415

E- Factor (g/mi) @		
Vehicle Type	35 mph	g/pkhr-mi
Snowmobiles	5.64	2228
Snowcoaches	11.2	224
Total	2452	5.91

E- Factor (g/mi) @		
Vehicle Type	15 mph	g/pkhr-mi
Snowmobiles	2.8	1106
Snowcoaches	8.6	172
Total	1278	3.08

E- Factor (g/hr) @		
Vehicle Type	Idle	g/pkhr-mi
Snowmobiles	0.93	367
Snowcoaches	4.4	88
Total	455	1.10

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Peak	
		Hour	# vehs / pk hr
Snowmobiles	600	65.8%	395
Snowcoaches	50	39.3%	20
Total pk hr			415

E- Factor (g/mi) @		
Vehicle Type	35 mph	g/pkhr-mi
Snowmobiles	0.031	12
Snowcoaches	0.05	1
Total	13	0.03

E- Factor (g/mi) @		
Vehicle Type	15 mph	g/pkhr-mi
Snowmobiles	0.065	26
Snowcoaches	0.06	1
Total	27	0.06

E- Factor (g/hr) @		
Vehicle Type	Idle	g/pkhr-mi
Snowmobiles	0.49	194
Snowcoaches	0.11	2
Total	196	0.47

# Snowmobiles		Emissions	
Staging Area	YS	# Snowcoaches	Emissions
Old Faithful	807	93	0.21
Flagg Ranch	400	33	0.09

# Snowmobiles		Emissions	
Staging Area	# Snowmobiles	# Snowcoaches	Emissions
Old Faithful	807	93	0.07
Flagg Ranch	400	33	0.04

Alternative 5

All snowmobiles "Improved BAT", except some Grassy Lake Road from Targhee NF

CO Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	220.6	242.9	266	0.0083
Snowmobile	Phase 1 2-Stroke	80.4	52.5	266	0.083
Snowmobile	Current BAT	35.1	22.9	191.5	
Snowmobile	Improved BAT	18.4	10.7	137.6	
Snowcoach	BAT	17.4	38.7	43.7	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	8.1	7.0	6.02	0.68	6.70
Mammoth to Norris	21	224.7	812.7	58.37	59.95	118.32
West Entrance to Madison	14	149.8	541.8	207.56	111.87	319.43
Madison to Norris	14	149.8	541.8	99.15	58.57	157.72
Norris to Canyon Village	12	128.4	464.4	59.82	32.23	92.05
Canyon Village to Fishing Bridge	16	171.2	619.2	109.77	44.34	154.11
Fishing Bridge to East Entrance	27	288.9	1044.9	57.41	15.35	72.76
Fishing Bridge to West Thumb	21	224.7	812.7	68.88	21.70	90.58
Madison to Old Faithful	16	171.2	619.2	241.59	138.84	380.43
Old Faithful to West Thumb	17	181.9	657.9	140.54	88.08	228.62
West Thumb to Flagg Ranch	24	256.8	928.8	180.52	108.92	289.44
GTNP CDST	24	256.8	928.8	56.56	0.00	56.56
GTNP Grassy	7	74.9	270.9	58.27	0.00	58.27
GTNP Jackson Lake	37.3	399.11	1443.51	70.33	0.00	70.33
Old Faithful Staging Area	NA	11.42	3.63	12.47	0.65	13.12
Flagg Ranch Staging Area	NA	11.42	3.63	6.74	0.21	6.95
Total				1434.01	681.39	2115.39

HC Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	179.9	78.7	473	0.0083
Snowmobile	Phase 1 2-Stroke	18.8	15.5	235.3	0.083
Snowmobile	Current BAT	2.82	2.32	35.3	
Snowmobile	Improved BAT	0.56	0.9	35.3	
Snowcoach	BAT	1.6	1	12	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.5	0.7	0.37	0.07	0.44
Mammoth to Norris	21	18.9	21	4.91	1.55	6.46
West Entrance to Madison	14	12.6	14	17.46	2.89	20.35
Madison to Norris	14	12.6	14	8.34	1.51	9.85
Norris to Canyon Village	12	10.8	12	5.03	0.83	5.86
Canyon Village to Fishing Bridge	16	14.4	16	9.23	1.15	10.38
Fishing Bridge to East Entrance	27	24.3	27	4.83	0.40	5.23
Fishing Bridge to West Thumb	21	18.9	21	5.79	0.56	6.35
Madison to Old Faithful	16	14.4	16	20.32	3.59	23.91
Old Faithful to West Thumb	17	15.3	17	11.82	2.28	14.10
West Thumb to Flagg Ranch	24	21.6	24	15.18	2.81	18.00
GTNP CDST	24	21.6	24	4.76	0.00	4.76
GTNP Grassy	7	6.3	7	16.51	0.00	16.51
GTNP Jackson Lake	37.3	33.57	37.3	5.92	0.00	5.92
Old Faithful Staging Area	NA	2.93	1.00	3.20	0.18	3.38
Flagg Ranch Staging Area	NA	2.93	1.00	1.73	0.06	1.79
Total				135.40	17.87	153.28

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Peak Hour	# vehs / pk hr
Snowmobiles	336	65.8%	221
Snowcoaches	44	39.3%	17
Total pk hr			238
E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	10.7	2365	10.70
Snowcoaches	38.7	658	38.70
Total	3023		12.70
E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	18.4	4066	18.40
Snowcoaches	17.4	296	17.40
Total	4362		18.33
E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	137.6	30410	137.60
Snowcoaches	43.7	743	43.70
Total	31153		130.89

West Entrance South Lane Traffic: 158.7
West Entrance North Lane Traffic: 79.3

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	496	81	13.12	9.84
Flagg Ranch	268	26.62	6.95	5.22

Alternative 5 continued

NOx Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	0.2	0.23	0.53	0.0083	West Entrance Old Faithful/Flagg Ranch
Snowmobile	Current BAT	2.8	5.64	0.93	0.083	
Snowmobile	Improved BAT	0.91	3.29	1.05		
Snowcoach	BAT	8.6	11.2	4.4		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.4	3.3	0.26	0.32	0.58
Mammoth to Norris	21	69.09	235.2	17.95	17.35	35.30
West Entrance to Madison	14	46.06	156.8	63.82	32.38	96.19
Madison to Norris	14	46.06	156.8	30.48	16.95	47.44
Norris to Canyon Village	12	39.48	134.4	18.39	9.33	27.72
Canyon Village to Fishing Bridge	16	52.64	179.2	33.75	12.83	46.58
Fishing Bridge to East Entrance	27	88.83	302.4	17.65	4.44	22.10
Fishing Bridge to West Thumb	21	69.09	235.2	21.18	6.28	27.46
Madison to Old Faithful	16	52.64	179.2	74.28	40.18	114.47
Old Faithful to West Thumb	17	55.93	190.4	43.21	25.49	68.70
West Thumb to Flagg Ranch	24	78.96	268.8	55.51	31.52	87.03
GTNP CDST	24	78.96	268.8	17.39	0.00	17.39
GTNP Grassy	7	23.03	78.4	3.03	0.00	3.03
GTNP Jackson Lake	37.3	122.72	417.76	21.62	0.00	21.62
Old Faithful Staging Area	NA	0.09	0.37	0.00	0.07	0.07
Flagg Ranch Staging Area	NA	0.09	0.37	0.05	0.02	0.07
Total				418.59	197.16	615.75

PM Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	3.86	1.02	3.77	0.0083	West Entrance Old Faithful/Flagg Ranch
Snowmobile	Current BAT	0.065	0.031	0.49	0.083	
Snowmobile	Improved BAT	0.068	0.034	0.54		
Snowcoach	BAT	0.06	0.05	0.11		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.0	0.0	0.02	0.00	0.02
Mammoth to Norris	21	0.714	1.05	0.19	0.08	0.26
West Entrance to Madison	14	0.476	0.7	0.66	0.14	0.80
Madison to Norris	14	0.476	0.7	0.32	0.08	0.39
Norris to Canyon Village	12	0.408	0.6	0.19	0.04	0.23
Canyon Village to Fishing Bridge	16	0.544	0.8	0.35	0.06	0.41
Fishing Bridge to East Entrance	27	0.918	1.35	0.18	0.02	0.20
Fishing Bridge to West Thumb	21	0.714	1.05	0.22	0.03	0.25
Madison to Old Faithful	16	0.544	0.8	0.77	0.18	0.95
Old Faithful to West Thumb	17	0.578	0.85	0.45	0.11	0.56
West Thumb to Flagg Ranch	24	0.816	1.2	0.57	0.14	0.71
GTNP CDST	24	0.816	1.2	0.18	0.00	0.18
GTNP Grassy	7	0.24	0.35	0.63	0.00	0.63
GTNP Jackson Lake	37.3	1.27	1.87	0.22	0.00	0.22
Old Faithful Staging Area	NA	0.04	0.01	0.05	0.00	0.05
Flagg Ranch Staging Area	NA	0.04	0.01	0.03	0.00	0.03
Total				5.02	0.88	5.90

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Peak	# vehs / pk hr
Snowmobiles	336	65.8%	221
Snowcoaches	44	39.3%	17
Total pk hr			238

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	3.29	727	3.29
Snowcoaches	11.2	190	11.20
Total		917	3.86

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	0.91	201	0.91
Snowcoaches	8.6	146	8.60
Total		347	1.46

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	1.05	232	1.05
Snowcoaches	4.4	75	4.40
Total		307	1.29

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Peak	# vehs / pk hr
Snowmobiles	336	65.8%	221
Snowcoaches	44	39.3%	17
Total pk hr			238

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	0.034	8	0.03
Snowcoaches	0.05	1	0.05
Total		8	0.04

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	0.068	15	0.07
Snowcoaches	0.06	1	0.06
Total		16	0.07

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	0.54	119	0.54
Snowcoaches	0.11	2	0.11
Total		121	0.51

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	496	81	0.07	0.049
Flagg Ranch	268	27	0.07	0.05

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	496	81	0.05	0.038
Flagg Ranch	268	27	0.0270	0.020

Alternative 6
Mixed-Use (plowing)

CO Emissions

	BAT Requirements	Emission Factors and Traveling Speeds			
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	Idle Time (hr)
Snow Equipment					
Snowmobile	2-Stroke	220.6	242.9	266	0.0083
Snowmobile	Phase 1 2-Stroke	80.4	52.5	266	0.083
Snowmobile	Current BAT	35.1	22.9	191.5	
Snowcoach	BAT	14.3	27.7	26.3	
Wheeled Vehicles		30.3	19.3	188.7	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Wheeled Vehicle Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Vehicle Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	14.93	5.65	13.08	0.00	0.00	2.16	2.16
Mammoth to Norris	21	480.9	581.7	405.3	0.00	0.00	60.26	60.26
West Entrance to Madison	14	320.6	387.8	270.2	0.00	0.00	79.60	79.60
Madison to Norris	14	320.6	387.8	270.2	0.00	0.00	40.92	40.92
Norris to Canyon Village	12	274.8	332.4	231.6	9.08	2.34	0.00	11.42
Canyon Village to Fishing Bridge	16	366.4	443.2	308.8	213.87	53.50	0.00	267.36
Fishing Bridge to East Entrance	27	618.3	747.9	521.1	0.00	0.00	0.00	0.00
Fishing Bridge to West Thumb	21	480.9	581.7	405.3	296.59	70.98	0.00	367.57
Madison to Old Faithful	16	366.4	443.2	308.8	0.00	0.00	102.03	102.03
Old Faithful to West Thumb	17	389.3	470.9	328.1	458.76	70.74	0.00	529.50
West Thumb to Flagg Ranch	24	549.6	664.8	463.2	556.86	30.75	0.00	587.61
GTNP CDST	24	549.6	664.8	463.2	0.00	0.00	0.00	0.00
GTNP Grassy	7	160.3	193.9	135.1	84.80	0.00	0.00	84.80
GTNP Jackson Lake	37.3	854.17	1033.21	719.89	150.51	0.00	0.00	150.51
Old Faithful Staging Area	NA	15.89	2.18	15.66	9.37	0.16	2.59	12.12
Flagg Ranch Staging Area	NA	15.89	2.18	15.66	10.50	0.05	0.00	10.55
Total					1790.34	228.53	287.55	2306.41

HC Emissions

	BAT Requirements	Emission Factors and Traveling Speeds			
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	Idle Time (hr)
Snow Equipment					
Snowmobile	2-Stroke	179.9	78.7	473	0.0083
Snowmobile	Phase 1 2-Stroke	18.8	15.5	235.3	0.083
Snowmobile	Current BAT	2.82	2.32	35.3	
Snowcoach	BAT	1.9	0.7	7.6	
Wheeled Vehicles		1.93	1.22	14.6	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Wheeled Vehicle Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Vehicle Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.36	0.79	0.85	0.00	0.00	0.14	0.14
Mammoth to Norris	21	48.72	14.7	25.62	0.00	0.00	3.81	3.81
West Entrance to Madison	14	32.48	9.8	17.08	0.00	0.00	5.03	5.03
Madison to Norris	14	32.48	9.8	17.08	0.00	0.00	2.59	2.59
Norris to Canyon Village	12	27.84	8.4	14.64	0.92	0.06	0.00	0.98
Canyon Village to Fishing Bridge	16	37.12	11.2	19.52	21.67	1.35	0.00	23.02
Fishing Bridge to East Entrance	27	62.64	18.9	32.94	0.00	0.00	0.00	0.00
Fishing Bridge to West Thumb	21	48.72	14.7	25.62	30.05	1.79	0.00	31.84
Madison to Old Faithful	16	37.12	11.2	19.52	0.00	0.00	6.45	6.45
Old Faithful to West Thumb	17	39.44	11.9	20.74	46.48	1.79	0.00	48.26
West Thumb to Flagg Ranch	24	55.68	16.8	29.28	56.42	0.78	0.00	57.19
GTNP CDST	24	55.68	16.8	29.28	0.00	0.00	0.00	0.00
GTNP Grassy	7	16.24	4.9	8.54	355.92	0.00	0.00	355.92
GTNP Jackson Lake	37.3	86.54	26.11	45.51	15.25	0.00	0.00	15.25
Old Faithful Staging Area	NA	2.93	0.63	1.21	1.73	0.00	0.00	1.73
Flagg Ranch Staging Area	NA	2.93	0.63	1.21	1.94	0.00	0.00	1.94
Total					530.36	5.77	18.02	554.14

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	Hour	# vehs / pk hr
Snowmobiles	0	65.6%	0
Snowcoaches	0	39.3%	0
Wheeled Vehicles	75	65.6%	49
Total pk hr			49

E- Factor (g/mi) @ 35			
Vehicle Type	mph	g/pkhr-mi	g/mi
Snowmobiles	22.9	0	0.00
Snowcoaches	27.7	0	0.00
Wheeled Vehicles	19.3	948	19.30
Total		946	19.30

E- Factor (g/mi) @ 15			
Vehicle Type	mph	g/pkhr-mi	g/mi
Snowmobiles	35.1	0	0.00
Snowcoaches	14.3	0	0.00
Wheeled Vehicles	30.3	1485	30.30
Total		1485	30.30

Vehicle Type	E- Factor (g/hr) @ Idle	g/pkhr-mi	g/hr
Snowmobiles	191.5	0	0.00
Snowcoaches	26.3	0	0.00
Wheeled Vehicles	188.7	9246	188.70
Total		9246	188.70

West Entrance North Lane Traffic: 16.3

Staging Area	# Snowmobiles	# Snowcoaches	# Wheeled Vehicles	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	268	34	75	12.12	9.09
Flagg Ranch	300	10.5	NA	10.50	7.92

Alternative 6 continued

NOx Emissions

	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snow Equipment	2-Stroke	0.2	0.23	0.33	0.0083
Snowmobile	Current BAT	2.8	5.64	0.93	0.083
Snowmobile	Improved BAT	0.91	3.29	1.05	
Snowcoach	BAT	8.6	11.2	4.4	
Wheeled Vehicles		7.33	5.86	28.2	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Wheeled Vehicle Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Vehicle Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.07	3.30	3.02	0.00	0.00	0.50	0.50
Mammoth to Norris	21	118.44	235.2	123.06	0.00	0.00	18.30	18.30
West Entrance to Madison	14	78.96	156.8	82.04	0.00	0.00	24.17	24.17
Madison to Norris	14	78.96	156.8	82.04	0.00	0.00	12.42	12.42
Norris to Canyon Village	12	67.68	134.4	70.32	2.24	0.95	0.00	3.18
Canyon Village to Fishing Bridge	16	90.24	179.2	93.76	52.67	21.63	0.00	74.30
Fishing Bridge to East Entrance	27	152.28	302.4	158.22	0.00	0.00	0.00	0.00
Fishing Bridge to West Thumb	21	118.44	235.2	123.06	73.05	28.70	0.00	101.75
Madison to Old Faithful	16	90.24	179.2	93.76	0.00	0.00	30.98	30.98
Old Faithful to West Thumb	17	95.88	190.4	99.62	112.99	28.60	0.00	141.59
West Thumb to Flagg Ranch	24	135.36	268.8	140.64	137.15	12.43	0.00	149.58
GTNP CDST	24	135.36	268.8	140.64	0.00	0.00	0.00	0.00
GTNP Grassy	7	39.48	78.40	41.02	5.72	0.00	0.00	5.72
GTNP Jackson Lake	37.3	210.37	417.76	218.58	37.07	0.00	0.00	37.07
Old Faithful Staging Area	NA	0.08	0.37	2.34	0.05	0.03	0.39	0.46
Flagg Ranch Staging Area	NA	0.08	0.37	2.34	0.05	0.01	0.00	0.06
Total					420.97	92.35	86.75	600.08

PM Emissions

	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snow Equipment	2-Stroke	3.86	1.02	3.77	0.0083
Snowmobile	Current BAT	0.065	0.031	0.49	0.083
Snowcoach	BAT	0.06	0.05	0.11	
Wheeled Vehicles		0.15	0.15	0.62	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Wheeled Vehicle Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Vehicle Emissions (lb/day)	Fugitive Road Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.03	0.02	0.06	0.00	0.00	0.01	1.94	1.95
Mammoth to Norris	21	0.651	1.05	3.15	0.00	0.00	0.47	96.46	96.93
West Entrance to Madison	14	0.434	0.7	2.1	0.00	0.00	0.62	127.42	128.04
Madison to Norris	14	0.434	0.7	2.1	0.00	0.00	0.32	65.50	65.81
Norris to Canyon Village	12	0.372	0.6	1.8	0.01	0.00	0.00	NA	0.02
Canyon Village to Fishing Bridge	16	0.496	0.8	2.4	0.29	0.10	0.00	NA	0.39
Fishing Bridge to East Entrance	27	0.837	1.35	4.05	0.00	0.00	0.00	NA	0.00
Fishing Bridge to West Thumb	21	0.651	1.05	3.15	0.40	0.13	0.00	NA	0.53
Madison to Old Faithful	16	0.496	0.8	2.4	0.00	0.00	0.79	163.32	164.11
Old Faithful to West Thumb	17	0.527	0.85	2.55	0.62	0.13	0.00	NA	0.75
West Thumb to Flagg Ranch	24	0.744	1.2	3.6	0.75	0.06	0.00	NA	0.81
GTNP CDST	24	0.744	1.2	3.6	0.00	0.00	0.00	NA	0.00
GTNP Grassy	7	0.217	0.35	1.05	0.35	0.00	0.00	NA	0.35
GTNP Jackson Lake	37.3	1.16	1.87	5.60	0.20	0.00	0.00	NA	0.20
Old Faithful Staging Area	NA	0.04	0.01	0.05	0.02	0.00	0.01	1.64	1.68
Flagg Ranch Staging Area	NA	0.04	0.01	0.05	0.03	0.00	0.00	NA	0.03
Total					2.68	0.41	2.22	456.28	461.59

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	Hour	# vehs / pk hr
Snowmobiles	0	65.8%	0
Snowcoaches	0	39.3%	0
Wheeled Vehicles	75	65.8%	49
Total pk hr			
49			

E- Factor			
Vehicle Type	(g/mi) @ 35	g/pkhr-mi	g/mi
Snowmobiles	5.64	0	0.00
Snowcoaches	11.2	0	0.00
Wheeled Vehicles	5.86	287	5.86
Total			
287			

E- Factor			
Vehicle Type	(g/mi) @ 15	g/pkhr-mi	g/mi
Snowmobiles	2.8	0	0.00
Snowcoaches	8.6	0	0.00
Wheeled Vehicles	7.33	359	7.33
Total			
359			

E- Factor			
Vehicle Type	(g/hr) @ Idle	g/pkhr-mi	g/hr
Snowmobiles	0.93	0	0.00
Snowcoaches	4.4	0	0.00
Plows	28.2	1382	28.20
Total			
1382			

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	Hour	# vehs / pk hr
Snowmobiles	0	65.8%	0
Snowcoaches	0	39.3%	0
Wheeled Vehicles	75	65.8%	49
Wheeled Vehicle Roads	75	65.8%	49
Total pk hr			
49			

E- Factor			
Vehicle Type	(g/mi) @ 35	g/pkhr-mi	g/mi
Snowmobiles	0.031	0	0.00
Snowcoaches	0.05	0	0.00
Wheeled Vehicles	0.15	7	0.15
Wheeled Vehicle Roads	7.72	378	7.72
Total			
385			

E- Factor			
Vehicle Type	(g/mi) @ 15	g/pkhr-mi	g/mi
Snowmobiles	0.065	0	0.00
Snowcoaches	0.06	0	0.00
Wheeled Vehicles	0.15	7	0.15
Wheeled Vehicle Roads	7.72	378	7.72
Total			
385			

E- Factor			
Vehicle Type	(g/hr) @ Idle	g/pkhr-mi	g/hr
Snowmobiles	0.49	0	0.00
Snowcoaches	0.11	0	0.00
Wheeled Vehicles	0.62	30	0.62
Total			
30			

		#	Emissions	Emissions
Staging Area	# Snowmobiles	Snowcoaches	(lb/day)	(lb/hr)
Old Faithful	268	34	0.46	0.345
Flagg Ranch	300	11	0.06	0.04

		#	# Wheeled	Emissions	Emissions
Staging Area	# Snowmobiles	Snowcoaches	Vehicles	(lb/day)	(lb/hr)
Old Faithful	268	34	75	1.68	1.258
Flagg Ranch	300	11	NA	0.0271	0.020

AP-42 FUGITIVE DUST (PM) FOR PAVED ROADS CALCULATIONS

Alternative 6 only

Vehicle Type	Percent Total Use	Weight - GVWR (ton)
LDG4 (Light-Duty Trucks 4)	34%	3.6
HDV2B (Class 2b Heavy-Duty Vehicles)	11%	4.6
HDV3 (Class 3 Heavy-Duty Vehicles)	11%	6.0
HDV4 (Class 4 Heavy-Duty Vehicles)	11%	7.5
HDBT (Transit and Urban Buses)	33%	20.0

Basis: AP-42 Section 13.2.1 Paved Roads

lbs/VMT Equation: $E=k (sL/2)0.65 (W/3)1.5$

Emission Area	Weighted Average Vehicle Weight (tons)	Emission Factor (lb/VMT)	Road Surface Silt Loading (g/m2)*	Particle Size Multiplier, k (dimensionless)
Internal Plant Roads (PM10)	9.83	0.07	1.2	0.016
Internal Plant Roads (PM2.5)	9.83	0.02	1.2	0.004

Segment	Daily Vehicles	Length of Segment (miles)	Total VMT/day	Daily Fugitive Emissions (lb/day)		Winter Season Fugitive Emissions (tpy)		MOBILE6 PM ₁₀ Exhaust Emissions (tpy)
				PM-10	PM-2.5	PM-10	PM-2.5	
West Entrance	75	0.38	29	2	0	0.1	0.0	0.00
Mammoth to Norris	67.5	21	1418	96	24	4.3	1.1	0.02
West Entrance to Madison	133.75	14	1873	127	32	5.7	1.4	0.03
Madison to Norris	68.75	14	963	65	16	2.9	0.7	0.01
Norris to Canyon Village	0	12	0	0	0	0.0	0.0	0.00
Canyon Village to Fishing Bridge	0	16	0	0	0	0.0	0.0	0.00
Fishing Bridge to East Entrance	0	27	0	0	0	0.0	0.0	0.00
Fishing Bridge to West Thumb	0	21	0	0	0	0.0	0.0	0.00
Madison to Old Faithful	150	16	2400	163	41	7.3	1.8	0.04
Old Faithful to West Thumb	0	17	0	0	0	0.0	0.0	0.00
West Thumb to Flagg Ranch	0	24	0	0	0	0.0	0.0	0.00
Old Faithful	75	0.32	24	2	0	0.1	0.0	0.00
Total Parkwide				456	114	20.5	5.1	0.10

Note:

MOBILE6 emissions include brake and tire wear.

*Table 13. 2.1-3. Winter multiplier for low volume roads reduced from X4 to X2. NPS in Yellowstone would spread sand conservatively. Application would be once a day or less, and only in shaded or icy areas.

Current Conditions

Current Snowmobile BAT. No Snowcoach BAT (2005/2006 Winter Season Fleet)

CO Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	220.6	242.9	266	0.0083
Snowmobile	Phase 1 2-Stroke	80.4	52.5	266	0.083
Snowmobile	Current BAT	35.1	22.9	191.5	
Snowcoach	No BAT	164.1	254.2	441.5	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	14.9	66.0	5.03	2.04	7.07
Mammoth to Norris	21	480.9	5338.2	22.90	138.16	161.06
West Entrance to Madison	14	320.6	3558.8	199.25	218.62	417.87
Madison to Norris	14	320.6	3558.8	77.11	126.52	203.62
Norris to Canyon Village	12	274.8	3050.4	48.22	68.20	116.42
Canyon Village to Fishing Bridge	16	366.4	4067.2	87.62	96.30	183.93
Fishing Bridge to East Entrance	27	618.3	6863.4	27.93	34.01	61.95
Fishing Bridge to West Thumb	21	480.9	5338.2	62.69	47.27	109.95
Madison to Old Faithful	16	366.4	4067.2	217.39	276.73	494.12
Old Faithful to West Thumb	17	389.3	4321.4	143.25	142.11	285.36
West Thumb to Flagg Ranch	24	549.6	6100.8	199.38	179.93	379.31
GTNP CDS	24	549.6	6100.8	0.00	0.00	0.00
GTNP Grassy	7	160.3	1779.4	51.34	0.00	51.34
GTNP Jackson Lake	37.3	854.17	9481.66	37.63	0.00	37.63
Old Faithful Staging Area	NA	15.89	36.64	7.64	1.85	9.49
Flagg Ranch Staging Area	NA	15.89	36.64	3.82	0.54	4.36
Total				1191.19	1329.89	2521.08

HC Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	179.9	78.7	473	0.0083
Snowmobile	Phase 1 2-Stroke	18.8	15.5	235.3	0.083
Snowmobile	Current BAT	2.82	2.32	35.3	
Snowcoach	No BAT	5.4	10.9	24.6	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.4	2.3	0.46	0.07	0.53
Mammoth to Norris	21	48.72	228.9	2.32	5.92	8.24
West Entrance to Madison	14	32.48	152.6	20.19	9.37	29.56
Madison to Norris	14	32.48	152.6	7.81	5.43	13.24
Norris to Canyon Village	12	27.84	130.8	4.89	2.92	7.81
Canyon Village to Fishing Bridge	16	37.12	174.4	8.88	4.13	13.01
Fishing Bridge to East Entrance	27	62.64	294.3	2.83	1.46	4.29
Fishing Bridge to West Thumb	21	48.72	228.9	6.35	2.03	8.38
Madison to Old Faithful	16	37.12	174.4	22.02	11.87	33.89
Old Faithful to West Thumb	17	39.44	185.3	14.51	6.09	20.61
West Thumb to Flagg Ranch	24	55.68	261.6	20.20	7.72	27.91
GTNP CDS	24	55.68	261.6	0.00	0.00	0.00
GTNP Grassy	7	16.24	76.3	14.36	0.00	14.36
GTNP Jackson Lake	37.3	86.54	406.57	3.81	0.00	3.81
Old Faithful Staging Area	NA	2.93	2.04	1.41	0.10	1.51
Flagg Ranch Staging Area	NA	2.93	2.04	0.70	0.03	0.73
Total				130.74	57.01	187.74

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	Vehicles/Pea k Hour	# vehs / pk hr
Snowmobiles	153	65.8%	101
Snowcoaches	14	39.3%	6
		Total pk hr	107

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	22.9	2313	22.90
Snowcoaches	254.2	1525	254.20
Total		3838	35.87

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	35.1	3545	35.10
Snowcoaches	164.1	985	164.10
Total		4530	42.33

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	191.5	19342	191.50
Snowcoaches	441.5	2649	441.50
Total		21991	205.52

West Entrance South Lane Traffic: 71.3
West Entrance North Lane Traffic: 35.7

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	218	23	9.49	7.12
Flagg Ranch	109	6.695	4.36	3.27

Current continued

NOx Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	0.2	0.23	0.53	0.0083
Snowmobile	Current BAT	2.8	5.64	0.93	0.083
Snowmobile	Improved BAT	0.91	3.29	1.05	
Snowcoach	No BAT	15.9	15.6	3.9	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.1	6.1	0.36	0.19	0.55
Mammoth to Norris	21	118.44	327.6	5.64	8.48	14.12
West Entrance to Madison	14	78.96	218.4	49.07	13.42	62.49
Madison to Norris	14	78.96	218.4	18.99	7.76	26.75
Norris to Canyon Village	12	67.68	187.2	11.88	4.19	16.06
Canyon Village to Fishing Bridge	16	90.24	249.6	21.58	5.91	27.49
Fishing Bridge to East Entrance	27	152.28	421.2	6.88	2.09	8.97
Fishing Bridge to West Thumb	21	118.44	327.6	15.44	2.90	18.34
Madison to Old Faithful	16	90.24	249.6	53.54	16.98	70.52
Old Faithful to West Thumb	17	95.88	265.2	35.28	8.72	44.00
West Thumb to Flagg Ranch	24	135.36	374.4	49.11	11.04	60.15
GTNP CDST	24	135.36	374.4	0.00	0.00	0.00
GTNP Grassy	7	39.48	109.2	3.30	0.00	3.30
GTNP Jackson Lake	37.3	210.37	581.88	9.27	0.00	9.27
Old Faithful Staging Area	NA	0.08	0.32	0.04	0.02	0.05
Flagg Ranch Staging Area	NA	0.08	0.32	0.02	0.00	0.02
Total				280.39	81.68	362.07

PM Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	3.86	1.02	3.77	0.0083
Snowmobile	Current BAT	0.065	0.031	0.49	0.083
Snowcoach	No BAT	0.06	0.05	0.11	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.0	0.0	0.01	0.00	0.01
Mammoth to Norris	21	0.651	1.05	0.03	0.03	0.06
West Entrance to Madison	14	0.434	0.7	0.27	0.04	0.31
Madison to Norris	14	0.434	0.7	0.10	0.02	0.13
Norris to Canyon Village	12	0.372	0.6	0.07	0.01	0.08
Canyon Village to Fishing Bridge	16	0.496	0.8	0.12	0.02	0.14
Fishing Bridge to East Entrance	27	0.837	1.35	0.04	0.01	0.04
Fishing Bridge to West Thumb	21	0.651	1.05	0.08	0.01	0.09
Madison to Old Faithful	16	0.496	0.8	0.29	0.05	0.35
Old Faithful to West Thumb	17	0.527	0.85	0.19	0.03	0.22
West Thumb to Flagg Ranch	24	0.744	1.2	0.27	0.04	0.31
GTNP CDST	24	0.744	1.2	0.00	0.00	0.00
GTNP Grassy	7	0.217	0.35	0.02	0.00	0.02
GTNP Jackson Lake	37.3	1.16	1.87	0.05	0.00	0.05
Old Faithful Staging Area	NA	0.04	0.01	0.02	0.00	0.02
Flagg Ranch Staging Area	NA	0.04	0.01	0.01	0.00	0.01
Total				1.58	0.26	1.84

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	Vehicles/Pea k Hour	# vehs / pk hr
Snowmobiles	153	65.8%	101
Snowcoaches	14	39.3%	6
Total pk hr			107

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	5.64	570	5.64
Snowcoaches	15.6	94	15.60
Total		663	6.20

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	2.8	283	2.80
Snowcoaches	15.9	95	15.90
Total		378	3.53

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	0.93	94	0.93
Snowcoaches	3.9	23	3.90
Total		117	1.10

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	% Vehicles/Pea	# vehs / pk hr
Snowmobiles	153	65.8%	101
Snowcoaches	14	39.3%	6
Total pk hr			107

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	0.031	3	0.03
Snowcoaches	0.05	0	0.05
Total		3	0.03

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	0.065	7	0.07
Snowcoaches	0.06	0	0.06
Total		7	0.06

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	0.49	49	0.49
Snowcoaches	0.11	1	0.11
Total		50	0.47

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	218	23	0.05	0.040
Flagg Ranch	109	7	0.00	0.02

Staging Area	# Snowmobiles	# Snowcoaches	Emissions (lb/day)	Emissions (lb/hr)
Old Faithful	218	23	0.02	0.015
Flagg Ranch	109	7	0.01	0.007

1999 Historical Conditions - No BAT requirements.

All 2-stroke Snowmobiles & 1999 Snowcoach Fleet

CO Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	220.6	242.9	266	0.0083	West Entrance Old Faithful/Flagg Ranch
Snowmobile	Current BAT	35.1	22.9	191.5	0.083	
Snowmobile	Improved BAT	18.4	10.7	137.6		
Snowcoach	No BAT (1999)	259.9	349	731.7		
Snowcoach	BAT	14.3	27.7	26.3		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	86.0	104.8	179.46	4.62	184.08
Mammoth to Norris	21	5100.9	7329	1451.06	166.44	1617.50
West Entrance to Madison	14	3400.6	4886	13021.53	436.51	13458.04
Madison to Norris	14	3400.6	4886	5065.92	203.19	5269.11
Norris to Canyon Village	12	2914.8	4188	3193.18	115.95	3309.14
Canyon Village to Fishing Bridge	16	3886.4	5584	5097.35	166.91	5264.25
Fishing Bridge to East Entrance	27	6558.3	9423	1953.91	50.85	2004.76
Fishing Bridge to West Thumb	21	5100.9	7329	3085.48	91.05	3176.53
Madison to Old Faithful	16	3886.4	5584	13482.73	510.92	13993.65
Old Faithful to West Thumb	17	4129.3	5933	6619.07	318.87	6937.93
West Thumb to Flagg Ranch	24	5829.6	8376	7705.60	403.30	8108.90
GTNP CDST	24	5829.6	8376	1540.86	0.00	1540.86
GTNP Grassy	7	1700.3	2443	320.21	0.00	320.21
GTNP Jackson Lake	37.3	9060.17	13017.7	2394.76	0.00	2394.76
Old Faithful Staging Area	NA	22.08	60.73	55.99	4.41	60.40
Flagg Ranch Staging Area	NA	22.08	60.73	20.18	1.46	21.64
Total				65187.29	2474.48	67661.77

HC Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)	
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	179.9	78.7	473	0.0083	West Entrance Old Faithful/Flagg Ranch
Snowmobile	Current BAT	2.82	2.32	35.3	0.083	
Snowmobile	Improved BAT	0.56	0.9	35.3		
Snowcoach	No BAT (1999)	8	17.4	37.8		
Snowcoach	BAT	1.9	0.7	7.6		

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	72.3	3.4	150.79	0.15	150.93
Mammoth to Norris	21	1652.7	365.4	470.15	8.30	478.44
West Entrance to Madison	14	1101.8	243.6	4219.00	21.76	4240.76
Madison to Norris	14	1101.8	243.6	1641.37	10.13	1651.50
Norris to Canyon Village	12	944.4	208.8	1034.60	5.78	1040.38
Canyon Village to Fishing Bridge	16	1259.2	278.4	1651.55	8.32	1659.87
Fishing Bridge to East Entrance	27	2124.9	469.8	633.07	2.54	635.61
Fishing Bridge to West Thumb	21	1652.7	365.4	999.70	4.54	1004.24
Madison to Old Faithful	16	1259.2	278.4	4368.43	25.47	4393.90
Old Faithful to West Thumb	17	1337.9	295.8	2144.59	15.90	2160.49
West Thumb to Flagg Ranch	24	1888.8	417.6	2496.63	20.11	2516.73
GTNP CDST	24	55.68	417.6	14.72	0.00	14.72
GTNP Grassy	7	16.24	121.8	3.06	0.00	3.06
GTNP Jackson Lake	37.3	86.536	649.02	22.87	0.00	22.87
Old Faithful Staging Area	NA	39.26	3.14	99.56	0.23	99.79
Flagg Ranch Staging Area	NA	39.26	3.14	35.89	0.08	35.96
Total				19985.95	123.30	20109.25

West Entrance/West Entrance to Madison			
Vehicle Type	Vehicles/day	Vehicles/Peak	# vehs / pk hr
Snowmobiles	947	65.8%	623
Snowcoaches	20	39.3%	8
Total pk hr			631

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	242.9	151327	242.90
Snowcoaches	349	2792	349.00
Total		154119	244.25

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	220.6	137434	220.60
Snowcoaches	259.9	2079	259.90
Total		139513	221.10

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	266	165718	266.00
Snowcoaches	731.7	5854	731.70
Total		171572	271.90

West Entrance South Lane Traffic: 420.7
West Entrance North Lane Traffic: 210.3

Historical continued

NOx Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	0.2	0.23	0.53	0.0083
Snowmobile	Current BAT	2.8	5.64	0.93	0.083
Snowmobile	Improved BAT	0.91	3.29	1.05	
Snowcoach	No BAT (1999)	20.4	19.9	3.1	
Snowcoach	BAT	8.6	11.2	4.4	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.1	7.8	0.17	0.34	0.51
Mammoth to Norris	21	4.83	417.9	1.37	9.49	10.86
West Entrance to Madison	14	3.22	278.6	12.33	24.89	37.22
Madison to Norris	14	3.22	278.6	4.80	11.59	16.38
Norris to Canyon Village	12	2.76	238.8	3.02	6.61	9.64
Canyon Village to Fishing Bridge	16	3.68	318.4	4.83	9.52	14.34
Fishing Bridge to East Entrance	27	6.21	537.3	1.85	2.90	4.75
Fishing Bridge to West Thumb	21	4.83	417.9	2.92	5.19	8.11
Madison to Old Faithful	16	3.68	318.4	12.77	29.13	41.90
Old Faithful to West Thumb	17	3.91	338.3	6.27	18.18	24.45
West Thumb to Flagg Ranch	24	5.52	477.6	7.30	23.00	30.29
GTNP CDST	24	5.52	477.6	1.46	0.00	1.46
GTNP Grassy	7	1.61	139.3	0.30	0.00	0.30
GTNP Jackson Lake	37.3	8.58	742.27	2.27	0.00	2.27
Old Faithful Staging Area	NA	0.04	0.26	0.11	0.02	0.13
Flagg Ranch Staging Area	NA	0.04	0.26	0.04	0.01	0.05
Total				61.80	140.86	202.67

PM Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	3.86	1.02	3.77	0.0083
Snowmobile	Current BAT	0.065	0.031	0.49	0.083
Snowmobile	Improved BAT	0.068	0.034	0.54	
Snowcoach	No BAT (1999)	0.05	0.05	0.11	
Snowcoach	BAT	0.06	0.05	0.11	

West Entrance
Old Faithful/Flagg Ranch

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.5	0.0	3.12	0.00	3.13
Mammoth to Norris	21	21.42	1.05	6.09	0.02	6.12
West Entrance to Madison	14	14.28	0.7	54.68	0.06	54.74
Madison to Norris	14	14.28	0.7	21.27	0.03	21.30
Norris to Canyon Village	12	12.24	0.6	13.41	0.02	13.43
Canyon Village to Fishing Bridge	16	16.32	0.8	21.41	0.02	21.43
Fishing Bridge to East Entrance	27	27.54	1.35	8.20	0.01	8.21
Fishing Bridge to West Thumb	21	21.42	1.05	12.96	0.01	12.97
Madison to Old Faithful	16	16.32	0.8	56.62	0.07	56.69
Old Faithful to West Thumb	17	17.34	0.85	27.80	0.05	27.84
West Thumb to Flagg Ranch	24	24.48	1.2	32.36	0.06	32.42
GTNP CDST	24	24.48	1.2	6.47	0.00	6.47
GTNP Grassy	7	7.14	0.35	1.34	0.00	1.34
GTNP Jackson Lake	37.3	38.05	1.87	10.06	0.00	10.06
Old Faithful Staging Area	NA	0.31	0.01	0.79	0.00	0.79
Flagg Ranch Staging Area	NA	0.31	0.01	0.29	0.00	0.29
Total				276.87	0.35	277.22

West Entrance/West Entrance to Madison			
%			
Vehicle Type	Vehicles/day	Vehicles/Peak	# vehs / pk hr
Snowmobiles	947	65.8%	623
Snowcoaches	20	39.3%	8
Total pk hr			631

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	0.23	143	0.23
Snowcoaches	19.9	159	19.90
Total		302	0.48

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	0.2	125	0.20
Snowcoaches	20.4	163	20.40
Total		288	0.46

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	0.53	330	0.53
Snowcoaches	3.1	25	3.10
Total		355	0.56

West Entrance/West Entrance to Madison			
Vehicles/Peak			
Vehicle Type	Vehicles/day	Hour	# vehs / pk hr
Snowmobiles	947	65.8%	623
Snowcoaches	20	39.3%	8
Total pk hr			631

E- Factor (g/mi) @			
Vehicle Type	35 mph	g/pkhr-mi	g/mi
Snowmobiles	1.02	635	1.02
Snowcoaches	0.05	0	0.05
Total		636	1.01

E- Factor (g/mi) @			
Vehicle Type	15 mph	g/pkhr-mi	g/mi
Snowmobiles	3.86	2405	3.86
Snowcoaches	0.05	0	0.05
Total		2405	3.81

E- Factor (g/hr) @			
Vehicle Type	Idle	g/pkhr-mi	g/hr
Snowmobiles	3.77	2349	3.77
Snowcoaches	0.11	1	0.11
Total		2350	3.72

		Emissions		Emissions	
Staging Area	# Snowmobiles	# Snowcoaches	(lb/day)	(lb/hr)	
Old Faithful	1151	33	0.13	0.098	
Flagg Ranch	415	11	0.05	0.03	

		Emissions		Emissions	
Staging Area	# Snowmobiles	# Snowcoaches	(lb/day)	(lb/hr)	
Old Faithful	1151	33	0.794	0.60	
Flagg Ranch	415	11	0.286	0.215	

YEAR 2010; 1983 Regulations

Phase I 2-stroke snowmobiles have different emission rates of CO and HC, only.

Snowmobile emissions based on 2010 engines; 20% uncontrolled 2-stroke, 65% modified & direct injection 2-stroke, and 15% 4-stroke.

Total Winter Season Emissions Summary	CO		HC		NOx		PM	
	lb/day	tpy	lb/day	tpy	lb/day	tpy	lb/day	tpy
	24,986	1,124	7,567	341	172	8	277	12

CO Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			% Snowmobiles	Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	220.6	242.9	266	20%	0.0083
Snowmobile	Phase I 2-Stroke	80.4	52.5	266	65%	0.083
Snowmobile	BAT	35.1	22.9	191.5	15%	
Snowcoach	No BAT	164.1	254.2	441.5		
Snowcoach	BAT	14.3	27.7	26.3		

Link	Distance (mi)	Snowmobile Unit Emissions (g)			Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
		2-Stroke	Phase 1 2-Stroke	BAT				
West Entrance	0.38	86.0	32.8	14.9	66.0	84.98	2.91	87.89
Mammoth to Norris	21	5100.9	1102.5	480.9	5338.2	514.59	121.23	635.82
West Entrance to Madison	14	3400.6	735	320.6	3558.8	4617.84	317.94	4935.78
Madison to Norris	14	3400.6	735	320.6	3558.8	1796.54	148.00	1944.53
Norris to Canyon Village	12	2914.8	630	274.8	3050.4	1132.40	84.46	1216.86
Canyon Village to Fishing Bridge	16	3886.4	840	366.4	4067.2	1807.68	121.57	1929.25
Fishing Bridge to East Entrance	27	6558.3	1417.5	618.3	6863.4	692.92	37.04	729.96
Fishing Bridge to West Thumb	21	5100.9	1102.5	480.9	5338.2	1094.21	66.32	1160.53
Madison to Old Faithful	16	3886.4	840	366.4	4067.2	4781.40	372.14	5153.54
Old Faithful to West Thumb	17	4129.3	892.5	389.3	4321.4	2347.33	232.25	2579.58
West Thumb to Flagg Ranch	24	5829.6	1260	549.6	6100.8	2732.65	293.75	3026.40
GTNP CDST	24	5829.6	1260	549.6	6100.8	546.44	0.00	546.44
GTNP Grassy	7	1700.3	367.5	160.3	1779.4	113.56	0.00	113.56
GTNP Jackson Lake	37.3	9060.17	1958.25	854.17	9481.66	849.26	0.00	849.26
Old Faithful Staging Area	NA	22.08	22.08	15.89	36.64	53.64	2.66	56.30
Flagg Ranch Staging Area	NA	22.08	22.08	15.89	36.64	19.33	0.88	20.22
Total						23184.77	1801.14	24985.90

20% of total snowmobiles are 2-stroke, 65% are Phase I 2-stroke, and 15% are BAT.

HC Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			% Snowmobiles	Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)		
Snowmobile	2-Stroke	179.9	78.7	473	20%	0.0083
Snowmobile	Phase I 2-Stroke	18.8	15.5	235.3	65%	0.083
Snowmobile	Current BAT	14.1	11.6	176.5	15%	
Snowmobile	Improved BAT	2.82	2.32	35.3		
Snowcoach	No BAT	5.4	10.9	24.6		
Snowcoach	BAT	1.9	0.7	7.6		

Link	Distance (mi)	Snowmobile Unit Emissions (g)			Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
		2-Stroke	Phase 1 2-Stroke	BAT				
West Entrance	0.38	72.3	9.1	6.8	2.3	44.63	0.10	44.73
Mammoth to Norris	21	1652.7	325.5	243.6	228.9	164.61	5.20	169.81
West Entrance to Madison	14	1101.8	217	162.4	152.6	1477.18	13.63	1490.82
Madison to Norris	14	1101.8	217	162.4	152.6	574.69	6.35	581.03
Norris to Canyon Village	12	944.4	186	139.2	130.8	362.24	3.62	365.86
Canyon Village to Fishing Bridge	16	1259.2	248	185.6	174.4	578.25	5.21	583.46
Fishing Bridge to East Entrance	27	2124.9	418.5	313.2	294.3	221.66	1.59	223.24
Fishing Bridge to West Thumb	21	1652.7	325.5	243.6	228.9	350.02	2.84	352.87
Madison to Old Faithful	16	1259.2	248	185.6	174.4	1529.50	15.96	1545.46
Old Faithful to West Thumb	17	1337.9	263.5	197.2	185.3	750.88	9.96	760.84
West Thumb to Flagg Ranch	24	1888.8	372	278.4	261.6	874.14	12.60	886.73
GTNP CDST	24	1888.8	372	278.4	261.6	174.80	0.00	174.80
GTNP Grassy	7	550.9	108.5	81.2	76.3	36.33	0.00	36.33
GTNP Jackson Lake	37.3	2935.51	578.15	432.68	406.57	271.67	0.00	271.67
Old Faithful Staging Area	NA	39.26	19.53	14.65	2.04	57.68	0.15	57.83
Flagg Ranch Staging Area	NA	39.26	19.53	19.53	2.04	21.46	0.05	21.51
Total						7489.73	77.25	7566.98

20% of total snowmobiles are 2-stroke, 65% are Phase I 2-stroke, and 15% are BAT.

2010 continued

NOx Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	0.2	0.23	0.53	0.0083
Snowmobile	Current BAT	2.8	5.64	0.93	0.083
Snowmobile	Improved BAT	0.91	3.29	1.05	
Snowcoach	No BAT	15.9	15.6	3.9	
Snowcoach	BAT	10.8	14.8	0.6	

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	0.1	6.1	0.17	0.27	0.00
Mammoth to Norris	21	4.83	327.6	1.37	7.44	0.44
West Entrance to Madison	14	3.22	218.4	12.33	19.51	8.81
Madison to Norris	14	3.22	218.4	4.80	9.08	31.84
Norris to Canyon Village	12	2.76	187.2	3.02	5.18	13.88
Canyon Village to Fishing Bridge	16	3.68	249.6	4.83	7.46	8.21
Fishing Bridge to East Entrance	27	6.21	421.2	1.85	2.27	12.29
Fishing Bridge to West Thumb	21	4.83	327.6	2.92	4.07	4.12
Madison to Old Faithful	16	3.68	249.6	12.77	22.84	6.99
Old Faithful to West Thumb	17	3.91	265.2	6.27	14.25	35.60
West Thumb to Flagg Ranch	24	5.52	374.4	7.30	18.03	20.52
GTNP CDST	24	5.52	374.4	1.46	0.00	25.32
GTNP Grassy	7	1.61	109.2	0.30	0.00	1.46
GTNP Jackson Lake	37.3	8.579	581.88	2.27	0.00	0.30
Old Faithful Staging Area	NA	0.04	0.32	0.11	0.02	2.27
Flagg Ranch Staging Area	NA	0.04	0.32	0.04	0.01	0.14
Total				61.80	110.44	172.24

PM Emissions

Snow Equipment	BAT Requirements	Emission Factors and Traveling Speeds			Idle Time (hr)
		15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	
Snowmobile	2-Stroke	3.86	1.02	3.77	0.0083
Snowmobile	Current BAT	0.065	0.031	0.49	0.083
Snowmobile	Improved BAT	0.068	0.034	0.54	
Snowcoach	No BAT	0.06	0.05	0.11	
Snowcoach	BAT	0.1	0.1	0.25	

Link	Distance (mi)	Snowmobile Unit Emissions (g)	Snowcoach Unit Emissions (g)	Snowmobile Emissions (lb/day)	Snowcoach Emissions (lb/day)	Total Emissions (lb/day)
West Entrance	0.38	1.5	0.0	3.12	0.00	3.13
Mammoth to Norris	21	21.42	1.05	6.09	0.02	6.12
West Entrance to Madison	14	14.28	0.7	54.68	0.06	54.74
Madison to Norris	14	14.28	0.7	21.27	0.03	21.30
Norris to Canyon Village	12	12.24	0.6	13.41	0.02	13.43
Canyon Village to Fishing Bridge	16	16.32	0.8	21.41	0.02	21.43
Fishing Bridge to East Entrance	27	27.54	1.35	8.20	0.01	8.21
Fishing Bridge to West Thumb	21	21.42	1.05	12.96	0.01	12.97
Madison to Old Faithful	16	16.32	0.8	56.62	0.07	56.69
Old Faithful to West Thumb	17	17.34	0.85	27.80	0.05	27.84
West Thumb to Flagg Ranch	24	24.48	1.2	32.36	0.06	32.42
GTNP CDST	24	24.48	1.2	6.47	0.00	6.47
GTNP Grassy	7	7.14	0.35	1.34	0.00	1.34
GTNP Jackson Lake	37.3	38.046	1.865	10.06	0.00	10.06
Old Faithful Staging Area	NA	0.31	0.01	0.79	0.00	0.79
Flagg Ranch Staging Area	NA	0.31	0.01	0.29	0.00	0.29
Total				276.87	0.35	277.22

APPENDIX I
VISCREEN MODELING FILES

(Please download: Appendix I VISCREEN Modeling Files.zip)

VISCREEN ANALYSIS

Determination of Virtual Point Source

Source/Observer Separation Distances:

Flagg Ranch

Staging area = 60m x 160m = 9,600 m²

$\sqrt{9,600 \text{ m}} = 98 \text{ m}$ (equal length of sides)

$sy_o = \sqrt{9,600} \div 4.3 = 22.8 \text{ m}$

Old Faithful

Staging area = 630 m x 1037m = 653,310 m²

$\sqrt{9,600 \text{ m}} = 808 \text{ m}$ (equal length of sides)

$sy_o = \sqrt{9,600} \div 4.3 = 188 \text{ m}$

WE to Madison

Distance of link = 22.5 km

$sy_o = 22.5 \div 4.3 = 5.25 \text{ km}$

West Entrance

Distance of link = 0.61

$sy_o = 0.61 \div 4.3 = 0.142 \text{ km}$

Source/Observer Distance (find midpoint):

Flagg Ranch: $0.098 \text{ km} \div 2 = 0.049 \text{ km}$

Old Faithful: $0.808 \text{ km} \div 2 = 0.404 \text{ km}$

WE to Madison: $22.5 \text{ km} \div 2 = 11.25 \text{ km}$

West Entrance: $0.61 \text{ km} \div 2 = 0.305 \text{ km}$

Determine Downwind Distance:

From chart using stability Class D:

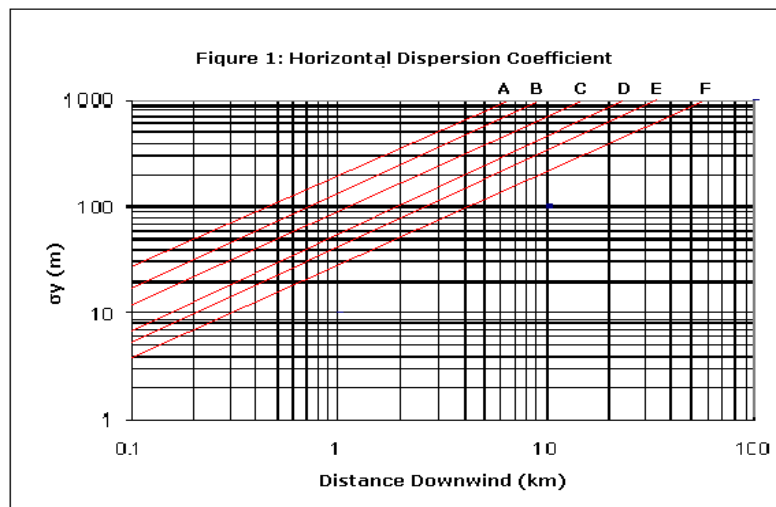
Flagg Ranch: At $sy_o = 22.8 \text{ m}$, $x = 0.35 \text{ km}$

Old Faithful: At $sy_o = 188 \text{ m}$, $x = 3.5 \text{ km}$

WE to Madison: At $sy_o = 5,230 \text{ m}$, $x = 120 \text{ km}$ (extrapolate)

West Entrance: At $sy_o = 142 \text{ m}$, $x = 2.5 \text{ km}$

Note: Use dispersion coefficient table with larger sy scale.



VISCREEN INPUT

Site	Source/Observer Distance (km)	Closest Distance Between S/O (km)	Furthest Distance Between S/O (km)
Flagg Ranch:	0.049	0.301	0.399
Old Faithful:	0.404	3.096	3.904
WE to Madison	11.25	108.75	131.25
West Entrance	0.305	2.195	2.805

Additional Input:

Background Visual Range = 240 km

Change stability class to D

Change wind speed to 1.0 m/s

APPENDIX J
MODELING STUDY PLAN

**FINAL
Air Quality Modeling Study Plan
Snowmobile and Snowcoach Emissions**

**WINTER USE PLAN
Environmental Impact Statement**

**YELLOWSTONE and GRAND TETON NATIONAL PARKS and the
JOHN D. ROCKEFELLER, JR., MEMORIAL PARKWAY**

April 24, 2006

Air Resource Specialists
1901 Sharp Point Drive, Suite E
Fort Collins, Colorado 80525

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Air Quality Modeling Study Plan
Winter Use Plan Environmental Impact Statement
Yellowstone and Grand Teton National Parks and The
John D. Rockefeller, Jr., Memorial Parkway

1.0 Introduction

This modeling study plan discusses the data and procedures for the Winter Use Plan/Environmental Impact Statement air quality analysis which will be completed for Yellowstone National Park (Yellowstone), Grand Teton National Park (Grand Teton), and the John D. Rockefeller, Jr. Memorial Parkway (Parkway). The potential air quality impacts from snowmobile and snowcoach operations for several scenarios identified will be quantified and assessed utilizing air dispersion modeling and other accepted methods and screening models. Oversnow motorized vehicle entry limits and other details for each of the modeling scenarios were provided by Yellowstone to Air Resource Specialists, Inc. (ARS).

Maximum predicted ambient concentrations of carbon monoxide (CO) and particulate matter (PM₁₀ and PM_{2.5}) will be calculated using U.S. Environmental Protection Agency (EPA) approved air quality models. Impacts for each scenario will be assessed with respect to the National Ambient Air Quality Standards (NAAQS) and relative to historical conditions and no-action scenarios. Modeling results will also be compared to Prevention of Significant Deterioration (PSD) increments for particulate matter, and potential visibility impacts for each scenario will be assessed. Winter-season emission estimates for criteria pollutants (CO, PM, and nitrogen oxides (NO_x)), hydrocarbons (HC), and hazardous air pollutants (HAPs) (benzene, 1,3 butadiene, formaldehyde, and acetaldehyde) will also be calculated.

2.0 Mobile Source Analysis

Estimates of maximum concentrations for pollutant averaging periods will be prepared to compare with the national ambient air quality standards. The prediction of CO and PM concentrations generated by over-snow vehicles must take into account emissions data, meteorological phenomena, vehicle traffic/travel conditions, and physical configurations.

The analysis will employ a modeling approach widely used for evaluating air quality impacts throughout the country. This approach will be coupled with a series of conservative assumptions for meteorology, traffic conditions, background concentration levels, etc. This combination results in conservative, yet realistic, estimates of expected pollutant concentrations and resulting potential impacts to air quality.

2.1 Dispersion Models

At the entrance stations and roadways selected for study, analysis will be performed using EPA's CAL3QHC model (*User's Guide to CAL3QHC, A Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections*, Office of Air Quality, Planning Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina). The CAL3QHC model is based on the CALINE-3 line source dispersion model with an additional algorithm for estimating vehicle queue lengths at signalized intersections. The refinement that CAL3QHC provides is the inclusion of the contribution of emissions from idling vehicles in the overall concentration. In this study, locations with snowmobiles and snowcoaches stopping and idling will be simulated with the characteristics of a signalized intersection for CAL3QHC modeling.

Air pollutant concentrations from emissions at the snowmobile staging areas will be evaluated with the Industrial Source Complex, Short Term dispersion model, Version 3 (ISC3), developed by EPA and described in the *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models* (EPA-454/B-95-003a). Since vehicles in staging areas are clustered (in the parking lots), the ISC3 model was selected, utilizing its area source dispersion modeling capabilities.

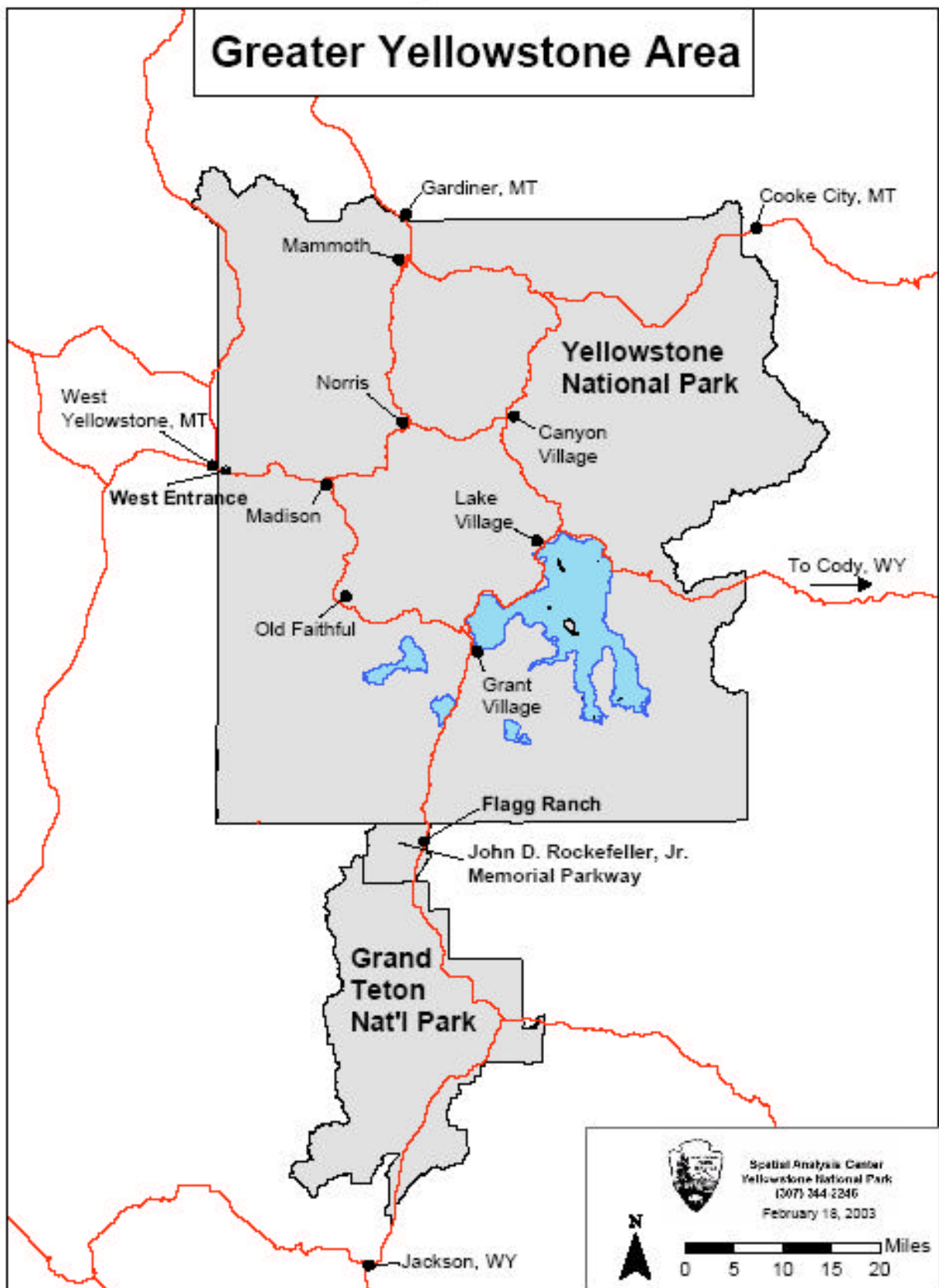
2.2 Modeling Locations

The locations in the parks selected for air quality modeling are expected to generate the most elevated ambient air quality impacts associated with snowmobile and snowcoach operations, due to expected vehicle traffic levels. The four locations (shown on Figure 1) are: Yellowstone's West Entrance, West Entrance to Madison Junction, Old Faithful Staging Area, and the Flagg Ranch Staging Area (in the Parkway). At these locations, multiple receptors (computer simulations of roadside locations near roadways) will be modeled for CAL3QHC along the approach and departure links at spaced intervals, outside of the mixing zone, the area of uniform emissions and turbulence. Similarly, a grid network of receptors will be modeled for ISC3 along the perimeters of the area sources representing vehicles at the staging areas. Ground-level receptors will be set at a default height of 6 feet. In addition, elevated flagpole receptors may also be modeled at locations where recent monitoring data has been collected to compare pollutant concentrations.

West Entrance

The West Entrance is a unique location for modeling as snowmobiles and snowcoaches approach the entrance station and then stop for a short time while entrance permits are checked. Vehicles experience delay and queuing traffic conditions. In addition, this location is in close proximity to West Yellowstone. Modeling will be

Figure 1



performed based on an average approach and departure speed of 15 miles per hour (mph) and an average engine idle time of 30 seconds at each kiosk. The approach and departure paths of the vehicles will be simulated by line sources or “links”, up to 1,000 feet in each direction from the West Entrance. CAL3QHC modeling will be performed for this intersection-type location.

West Entrance to Madison Link

For many of the scenarios, this modeling location is expected to have the highest traffic volumes compared to other roadway segments in Yellowstone, Grand Teton, and the Parkway. This is expected to result in elevated emissions and associated impacts from snowmobile and snowcoach traffic. CAL3QHC modeling will be performed for the free-flow roadway segments of this location, employing emissions data for snowmobiles traveling at 35 to 45 mph (see discussion of modes below). In winter, the speed limit for this road segment is 35 mph, whereas the limit is 45 mph for most of the park. As discussed above, vehicle traffic levels will be based on the proposed entry limits in the winter use plan for each scenario.

Old Faithful and Flagg Ranch Staging Areas

The Old Faithful and Flagg Ranch staging areas were selected for modeling because of the concentration of emissions from snowmobiles and snowcoaches bringing visitors to the Old Faithful Geyser Basin and parking area, and Flagg Ranch (in the Parkway). The primary contributor of emissions is due to the idling of engines after visitors enter and also prior to leaving these staging areas.

At the staging areas, emissions are clustered in distinct areas (the parking lots). Therefore, the ISC3 model was selected for area source modeling. Emissions at the staging area will be calculated only for engine idling, which is assumed to be five minutes on average for each vehicle. Engine emission calculations for the staging area will not explicitly include ingress and egress emissions from the vehicles, as this will be included in the roadway segment emissions. It will be conservatively assumed that all vehicles traveling Madison and West Thumb segments to Old Faithful will enter the Old Faithful staging area and that all vehicles traveling to Yellowstone’s South Entrance will enter the Flagg Ranch staging area, to maximize the number of vehicles included in the modeling for these sites.

2.3 Vehicle Emissions Data

To predict ambient concentrations of pollutants generated by vehicular traffic, emissions from vehicle exhaust systems must be estimated accurately. This analysis focuses primarily on emissions associated with visitor use of snowmobiles and snowcoaches and does not address other snowmobile use or other modes of vehicle travel within the park. However, one scenario under consideration would provide guided visitor access by on-road vehicles, by plowing certain roadways. Administrative vehicles are not

included in any of the modeling, as their emissions are represented in the pollutant background concentrations for this analysis. In general, the scenarios to be analyzed will include only visitor snowmobile and snowcoach travel and do not affect other modes of transportation.

Emissions data and vehicle usage data (discussed below) will be used for atmospheric dispersion modeling analyses to calculate the ambient levels of CO, PM₁₀, and PM_{2.5} at four locations within the parks, for the modeling scenarios. Emissions data will also be utilized to predict the total winter-season emissions of CO, PM, NO_x, HC, and HAPs (benzene, 1,3 butadiene, formaldehyde, and acetaldehyde) due to the operations of snowmobiles and snowcoaches in the park. The data to be employed for this analysis will be obtained from past air quality and emissions testing, research studies, as well as from vehicle manufacturers. However, snowmobile laboratory test data utilized below may not reflect actual operating conditions in Yellowstone, Grand Teton, and the Parkway, as high altitude and low winter temperatures in the parks are likely to decrease overall snowmobile emission performance.

For the historical conditions, the air quality analysis will assume that all snowmobiles are 2-stroke engines (see the next paragraph for more explanation of new EPA 2-stroke emissions regulations). For most modeling scenarios, the analysis will assume that all snowmobiles are 4-stroke engines meeting NPS Best Available Technology (BAT) requirements (or better, in some scenarios, as defined below). For the no action scenarios, the analysis will assume no snowmobile BAT requirements, replicating historic unregulated conditions. Current BAT for snowmobiles operating in Yellowstone, Grand Teton, and the Parkway has been established for CO and HC emissions, at less than 120 and 15 grams per kilowatt hour, respectively. The National Park Service (NPS) is also considering implementing an “improved” snowmobile BAT requirement of less than 79 and 3.2 grams per kilowatt hour for CO and HC, respectively. This improved snowmobile BAT requires lower CO and HC emissions than the current is BAT and is being considered by NPS to further reduce overall snowmobile emissions in the parks. Additional information on “improved” BAT for snowmobiles is provided below. Current and “improved” BAT requirements are shown in Table 1.

In addition, EPA adopted new standards for new non-road engines in 2002. For snowmobiles, the new standards will begin to take effect for the 2006 model year, with a 50 percent phase-in requirement. These standards and the corresponding implementation years are also provided in Table 1. Since they are less stringent than NPS BAT requirements, EPA standards would only be applicable (for modeling purposes) to the no action scenarios mentioned above, and to some snowmobiles that enter the Parkway from Targhee National Forest, via Grassy Lake Road. For these situations, the 2-stroke vs. 4-stroke mix will be determined based on replacement rates and future mix estimates in the Final Regulatory Support Document (EPA420-R-02-022) for EPA’s *Final Rule for Cleaner Large Industrial Spark-Ignition Engines, Recreational Marine Diesel Engines, and Recreational Vehicles* (published November 8, 2002).

All 2-stroke engine emissions data are based on the average emissions from snowmobiles tested by the equipment manufacturer or by the Southwest Research Institute (SwRI). 4-stroke engine emissions data are based on manufacturers' EPA certification modal emission testing results. These snowmobile emissions data were previously presented in the *Temporary Winter Use Plans Environmental Assessment*, National Park Service, August 2004. Composite emission factors for each modeling scenario will be calculated by weighting the snowmobile and snowcoach emission factors appropriate for each particular modeling scenario according to usage levels of each vehicle type. These composite emission factors (weighted averages) will be inputted to the CAL3QHC modeling.

Table 1
Snowmobile BAT Requirements and EPA Standards

	Emission Requirement or Standard		Phase-in*
	Hydrocarbons (HC) (g/KW-hr)	Carbon Monoxide (CO) (g/KW-hr)	
NPS BAT	15	120	-
Proposed "Improved" BAT	3.2	79	-
EPA Emission Standards			
Model Year			
2006	100	275	50%
2007-2009	100	275	100%
2010	75	275	100%
2012	75	200	100%
Note: Improved BAT based on testing from SwRI's <i>Laboratory Testing of Snowmobile Emissions</i> , Lela and White, July 2002.			
* Percent of newly manufactured sleds for the model year that must meet the applicable requirement.			

2.3.1 2-Stroke Snowmobile Emissions

Emission factors for 2-stroke snowmobiles are calculated based on tests performed by SwRI (*Emissions from Snowmobile Engines Using Bio-Based Fuels and Lubricants*, Southwest Research Institute, October 1998). Emission testing and engine performance were measured during modal engine tests following standard EPA test procedures. 2-stroke snowmobile emission factors for CO and HC are calculated from engine horsepower output, in grams per mile for traveling vehicles and in grams per hour for idling vehicles, using information in the SwRI report, which was prepared for the State of Montana Department of Environmental Quality.

The modal testing obtained data for five varying modes of operation. Mode 5 (a slow engine speed: 1,600 revolutions per minute, rpm) approximates conditions when an

engine is idling. Mode 4 (a moderate engine speed: 4,550 rpm) is representative of a snowmobile traveling at a speed of approximately 15-20 miles per hour, Mode 3 (an engine speed: 5,250 rpm) is representative of a snowmobile traveling at a speed of approximately 20-35 miles per hour, and Mode 2 (a higher engine speed: 5,950 rpm) represents a snowmobile speed of 35-45 miles per hour. Mode 1 (a high engine speed: 7,000 rpm) is representative of snowmobiles traveling over 45 miles per hour. Modes 4 and 2 were selected as reasonable approximations of slow and higher snowmobile travel speeds within the parks. Four different engines tested by SwRI were used to calculate average 2-stroke snowmobile emissions. For this analysis, emission factors were determined from modal testing data for the following operating conditions: Modes 5, 4, and 2. To convert emission factors from grams per hour to grams per mile, an equation provided via email (privileged and confidential) from Chris Wright of Arctic Cat, to Aaron Worstell of the National Park Service in July 2004 was utilized to determine speed from power. Table 2 summarizes the average emissions for 2-stroke snowmobile engines operating under those conditions.

Table 2
Snowmobile Emission Factors

	PM			CO			HC			NO _x		
	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)
2-Stroke snowmobiles	3.77	3.86	1.02	266	220.6	242.9	473	179.9	78.7	0.53	0.20	0.23
BAT 4- Stroke snowmobiles	0.49	0.065	0.031	191.5	35.1	22.9	35.3	2.82	2.32	0.93	2.80	5.64
Improved BAT 4- Stroke snowmobiles	0.54	0.068	0.034	137.6	18.4	10.7	35.3	0.56	0.90	1.05	0.91	3.29

2.3.2 4-Stroke Snowmobile Emissions

4-stroke snowmobile emission factors were calculated in the same manner as for 2-stroke engines. 4-stroke emission factors were determined from manufacturers' EPA certification modal emission testing results for the BAT-approved snowmobile engines of three different manufacturers (Arctic Cat T660, Polaris Frontier, and SkiDoo Legend with Yellowstone BAT kit). The average 4-stroke snowmobile emissions based on this data are shown in Table 2. As described above for 2-stroke snowmobiles, 4-stroke emission factors in grams per mile were calculated using an equation provided by Chris Wright of Arctic Cat.

NPS is also considering implementing an improved BAT emissions requirement, based on the Polaris 4-stroke Frontier snowmobile tested in the SwRI's *Laboratory*

Testing of Snowmobile Emissions, Lela and White, July 2002. The Polaris was selected over the other 4-stroke tested, an Arctic Cat, since its emissions were generally lower. The improved BAT emission requirements were determined from composite five-mode ISMA/SwRI cycle engine dynamometer test results of the Polaris with reference gasoline (no ethanol) for HC and CO and were previously presented in Table 1. These proposed requirements shown in Table 1, in grams per kilowatt-hour, are based on grams per horsepower-hour test results present in the above-referenced report. “Improved” BAT cruise emission factors for modeling purposes were calculated (from grams per hour test results) with the power to speed conversion from Arctic Cat and are included in Table 2. (The calculations are included as Appendix A.) Some modeling scenarios will assume implementation of the “improved” BAT for snowmobiles.

2.3.3 *Snowcoach Emissions*

Snowcoach emissions information for this analysis were obtained from the University of Denver’s *In-use Emission Measurements of Snow Coaches and Snowmobiles in Yellowstone National Park*, Gary A. Bishop, Daniel A. Burgard, Thomas R. Dalton, and Donald H. Stedman, January 2006. This study included measuring emissions from nine snowcoaches operating in Yellowstone during February of 2005 and provides the most comprehensive collection of emissions data from in-use snowcoaches to date. A summary of the idle and traveling (low speeds of less than 15 mph and cruise speeds of 15 to 35 mph) emissions is shown in Table 3, representing current fleet emissions for modeling purposes. Since the nine snowcoaches measured in the study are not fully representative of the mix of vehicles in the overall snowcoach fleet operating in Yellowstone, emission factors were determined by weighting the data from the study based on the current fleet mix of snowcoaches operating in Yellowstone, by engine type and age (See Appendix B). With respect to current snowcoach emission technology requirements, this analysis assumes all non-historic snowcoaches meet the EPA standards in effect when the vehicle/engine was manufactured. It should be noted that a new University of Denver study of Yellowstone snowmobile and snowcoach emissions during the winter season of 2006 is expected in the near future.

The National Park Service is also considering implementing a snowcoach BAT requirement and is leaning toward using Tier 2 light-duty vehicle emission standards as a primary basis. Separate requirements would also need to be developed for heavy-duty/diesel snowcoaches, possibly based on EPA’s Heavy-duty Diesel regulation. However, for modeling purposes, the emissions of the cleanest snowcoaches tested in the University of Denver study were selected and averaged, representing the proposed snowcoach BAT emission values. These emission factors are included in Table 3 and the calculations are provided in Appendix B.

Table 3
Snowcoach Emission Factors for Modeling

	PM*			CO			HC			NO _x		
	Idle (g/hr)	< 15 mph (g/mi)	15 to 35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	15 to 35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	15 to 35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	15 to 35 mph (g/mi)
Snowcoaches – Current Fleet	0.25	0.10	0.10	376.4	227.4	228.9	29.2	8.4	19.8	4.1	14.9	15.2
BAT Snowcoaches	0.25	0.10	0.10	26.3	14.3	27.7	7.6	1.9	0.7	0.6	10.8	14.8

Note:

* PM emissions measured only from NPS Van (diesel engine).

Source: *In-use Emission Measurements of Snow Coaches and Snowmobiles in Yellowstone National Park*, University of Denver, Bishop, Burgard, Dalton, and Stedman, January 2006.

2.3.4 On-road Vehicle Emissions

For analysis of a scenario that includes plowing of Yellowstone’s west-side roads, on-road (wheeled) vehicular emissions (CO, PM, NO_x and HC) will be computed using the EPA-developed Mobile Source Emissions Model (MOBILE6). Emission estimates will be made for up to five classes of motor vehicles: light-duty, gasoline-powered trucks (LDGT3 and LDGT4); heavy-duty, gasoline-powered trucks (HDGV); heavy-duty, diesel vehicles (HDDV); gasoline buses (HDGB); and diesel buses (HDDBT). The types of on-road vehicles in the fleet for this scenario will be limited, as vehicle entry would only be commercially guided. It is expected that this analysis will estimate one third of each of the following vehicle types: Suburban/large passenger truck or similar; 12-15 person vans/small buses or similar light-duty trucks; and large, heavy-duty buses (30-40 feet in length). MOBILE6 emission estimates will be prepared to account for current winter inputs such as temperature and fuel parameters, etc. (e.g., fuel volatility). Vehicle classification data will be obtained from Yellowstone, and national default vehicle age distributions will be used.

Emission estimates typically account for three possible vehicle operating conditions: cold vehicle operation, hot start operation, and hot stabilized operation. It is important to distinguish between these three operating categories, because vehicles emit pollutants at different rates depending on whether they are cold or warmed up. Since local data for Yellowstone is not available, MOBILE6 defaults will be employed for operating conditions.

2.4 Traffic Data

Traffic data for the air quality analysis will be derived from snowmobile and snowcoach entry limits and other information for each scenario provided to ARS by NPS. Microscale, or localized, dispersion modeling analysis will be conducted for the peak hour periods that produce the highest levels of vehicle traffic at each of the four modeling

locations, and therefore have the greatest potential for significant air quality impacts. Estimated daily vehicle miles traveled (VMT) for oversnow and on-road vehicles (in one scenario: plowing west-side roads) were provided by Yellowstone to ARS.

2.5 Meteorological Conditions

Following EPA guidelines, conservative meteorological conditions will be selected for the modeling, to produce the expected highest ambient concentrations. These conservative conditions selected for CAL3QHC pollutant computations include a low wind speed of 1 meter/second and stability class F (very thermally stable). The CAL3QHC model will be utilized to vary the wind angle, to determine the wind direction which will maximize pollutant concentrations at each of the locations for analysis.

Since ISC3 requires actual meteorological data input, a two month (January 1, 2000 through February 28, 2000) winter data set from the West Entrance monitoring site will be used for modeling. Even though sequential meteorological data were used, the results will be treated in a conservative manner because of the limited meteorological data set. The ISC3 results will be evaluated to determine the maximum predicted 1-hour average impacts (regardless of the time period(s) the impacts occurred) and maximum prediction 8-hour CO and 24-hour PM concentrations will be determined using persistence factors. This approach assumes that the worst-case meteorology may occur concurrently with the periods of peak emissions. In addition, the default meteorological data used by the SCREEN3 model, which includes the full range of stability classes and windspeed combinations, will be input to ISC3 model runs of the staging areas to determine potential impacts under meteorological conditions not measured during the monitored meteorological period.

2.6 Background Concentrations

Background concentrations are those pollutant concentrations not directly accounted for by the modeling analysis. Background concentrations must be added to modeling results to obtain total pollutant concentrations at prediction sites. Background concentrations can typically be attributed to local sources, long-range transport and nonanthropogenic sources. For this analysis, background levels would include smoke (from wood-burning stoves and fireplaces) and other emissions from West Yellowstone. Background concentrations for this analysis will be estimated using the guidelines provided in *40 CFR Part 51, Appendix W*.

For the West Entrance, 1995 data collected in West Yellowstone provided background concentration estimates of an 1-hour average CO background of 3.0 ppm, which have been employed for previous analyses. Also, all 1-hour CO concentrations collected at West Yellowstone from October 1998 through December 2001 (*Carbon Monoxide Monitoring in West Yellowstone, Montana 1998-2001*, John Coefield, Montana Department of Environmental Quality, May 2002), that were not directly affected by winter season snowmobile traffic were less than 3 ppm, with the exception of one hour

(August 2000). Background concentrations for other averaging periods will be determined based on available data or by applying a persistence factor (discussed below). The 24-hour average PM₁₀ and PM_{2.5} background concentrations were determined from the IMPROVE network aerosol data and are 4.2 and 2.4 micrograms per cubic meter (gravimetric mass average of 2002-04 annual mean values), respectively. IMPROVE data provides representative background concentration levels not directly affected by winter oversnow vehicle emissions.

For the 8-hour average CO and 24-hour average PM_{2.5} concentrations, the highest 1-hour average concentrations for each pollutant will be converted to an 8-hour and 24-hour averaging periods using persistence factors calculated from the *Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005*, Air Resource Specialists, August 2005. As recommended by EPA's *Guideline for Modeling Carbon Monoxide from Roadway Intersections*, November 1992, these factors are determined based on the ratio of actual 8-hour to 1-hour CO measurements collected at the West Entrance or Old Faithful monitoring stations for the latest three seasons of monitoring data and averaged. This was similarly used to determine persistence factors for calculating 24-hour average PM_{2.5} concentrations.

2.7 Emissions Inventory

Total maximum potential mobile source emissions due to operations of snowmobiles and snowcoaches in Yellowstone, Grand Teton and the Parkway in tons per winter season will be calculated for each scenario, based on vehicle entry limits. The winter season is assessed as a 90 day period that typically runs from about mid-December to early March. Estimates will be prepared for criteria pollutants (CO, PM, and NO_x), HC, and HAPs (benzene, 1,3 butadiene, formaldehyde, and acetaldehyde). Emissions will be calculated using travel estimates of oversnow and on-road vehicles used on Yellowstone and Grand Teton roadways, the roadway lengths, and modes of operation of the vehicles. Emissions data previously discussed above in Section 2.3 will be applied to the vehicle traffic levels for each scenario to determine total park-wide emissions for each pollutant.

2.8 Hazardous Air Pollutant (HAP) Emissions

Emissions of HAPs occur in snowmobile emissions and are associated with incomplete fuel combustion in the engine. These emissions were estimated as a fraction of measured HC emissions from 2-stroke and 4-stroke snowmobiles based on data reported in SwRI's *Laboratory Testing of Snowmobile Emissions*, Lela and White, July 2002. HAPs classified as air toxics (benzene, 1-3 butadiene, formaldehyde, and acetaldehyde) are presented in Table 4 as a percentage of the total HC mass.

Table 4
Snowmobile HC Speciation Data

	2-stroke (percent of HC)	4-stroke (percent of HC)
Benzene	0.64 %	2.60 %
1-3 Butadiene	0.11 %	0.00 %
Formaldehyde	0.67 %	2.81 %
Acetaldehyde	0.47 %	1.08 %

HAPs emissions from on-road vehicles will be determined using MOBILE6. HAPs emissions from snowcoaches will be calculated using the percentages of the total HC mass derived from MOBILE6, based the on-road vehicle types that are converted to snowcoaches (or the closest engine type) and the snowcoach HC emissions data from the University of Denver testing. HAP emissions will not be modeled as part of the microscale analysis, but evaluated by the winter-season emissions inventory discussed above.

3.0 Visibility

Yellowstone and Grand Teton are classified as Class I areas under the Federal Clean Air Act. This air quality classification is to provide protection against air quality degradation in national park and wilderness areas. Therefore, an analysis of potential visibility impacts resulting from on-snow vehicle emissions will be conducted following procedures in the *Workbook for Plume Visual Impact Screening and Analysis*, EPA-450/4-88-015, 1992. The EPA model VISCREEN incorporates the methodology and will be used to conduct a Level 1 screening analysis of potential visibility impacts. Virtual point source methods will be applied to adapt procedures originally designed for assessing plume impacts resulting from industrial stacks to the line and area sources at the locations in this modeling analysis.

4.0 Results and Comparison to NAAQS

As noted previously, receptors were placed at multiple locations at the four modeling locations. The receptor with the highest predicted concentrations will be used to represent each modeling site for each modeling scenario. CO and PM concentrations will be calculated for each location, for each scenario.

Impacts for each scenario will be assessed with respect to the National Ambient Air Quality Standards (NAAQS) and relative to historical conditions and no-action scenarios. The NAAQS for CO is 35 and 9 parts per million (ppm), for the 1-hour and 8-hour averaging periods, respectively. The CAL3QHC modeling results can be compared directly to the 1-hour average NAAQS, as the model simulates a 1-hour time period. CO 8-hour averages from modeling results will be determined from 1-hour concentrations using a persistence factor, previously discussed above. The NAAQS for PM₁₀ is 150 and 50 micrograms per cubic meter, for the 24-hour and annual averaging periods,

respectively. For PM_{2.5}, the NAAQS is 65 and 15 micrograms per cubic meter, for the 24-hour and annual averaging periods, respectively. For Wyoming, Montana, and Idaho, the applicable state standards for CO and particulates are the same as the federal standards, with the exception of the 1-hour CO standard in Montana, which is 23 ppm. The NAAQS are shown in Table 5.

In addition, the modeling results will be used to develop air quality-related thresholds (as was done in the Winter Use Plans Final Supplemental Environmental Impact Statement). Information provided by this modeling effort, along with air quality monitoring data, EPA's comments, and other information, will be considered by NPS in developing those thresholds.

Table 5
National Ambient Air Quality Standards

Pollutant	Primary		Secondary	
	PPM	Micrograms Per Cubic Meter	PPM	Micrograms Per Cubic Meter
Carbon Monoxide (CO)				
Maximum 8-Hour Concentration ¹	9		None	
Maximum 1-Hour Concentration ¹	35			
Respirable Particulates (PM₁₀)				
Annual Arithmetic Mean ²		50	Same as Primary	
Maximum 24-Hour Concentration ¹		150		
Respirable Particulates (PM_{2.5})				
Annual Arithmetic Mean ³		15	Same as Primary	
Maximum 24-Hour Concentration ⁴		65		
Notes: ¹ Not to be exceeded more than once per year. ² To attain this standard, the 3-year average of the weighted annual mean PM ₁₀ concentration at each monitor within an area must not exceed 50 ug/m ³ . ³ To attain this standard, the 3-year average of the weighted annual mean PM _{2.5} concentrations from single or multiple community-oriented monitors must not exceed 15.0 ug/m ³ . ⁴ To attain this standard, the 3-year average of the 98 th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 65 ug/m ³ . PPM = parts per million				
Source: 40 CFR Part 50—National Primary and Secondary Ambient Air Quality Standards				

Since Yellowstone and Grand Teton are classified as Federal Class I areas, PM₁₀ increment comparison under PSD will be assessed. PSD increments are the maximum permitted increases in pollutant concentrations over baseline levels. For Class I areas, the PM₁₀ PSD increments are 4 and 8 micrograms per cubic meter, for the annual and 24-hour averaging periods, respectively. Since vehicle emissions will be considered increment consuming or contributing sources for this analysis, PM₁₀ concentrations determined for each modeling scenario will be assessed with respect to the previously established (by Montana and Wyoming) baseline date of 1979 for Yellowstone (*Air Quality Concerns Related to Snowmobile Usage in National Parks*, National Park Service

Air Resources Division, February 2000). This assessment is a screening level approach and may indicate that a detailed analysis is required if concentrations are near the PM₁₀ PSD increments. Furthermore, methodology employed in this study reflects a screening-level analysis that is not intended for regulatory purposes and does not constitute a regulatory PSD increment consumption analysis.

The discussion of results for some modeling scenarios will also evaluate how modeled concentrations compare with historical (pre-2000) monitoring data and recent data from the last couple of winters (2003-04 and 2004-05), collected at the West Entrance and Old Faithful, e.g. from *Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005*, Air Resource Specialists, August 2005.

APPENDIX A SNOWMOBILE IMPROVED BAT

Yellowstone National Park Proposed Improved BAT Snowmobile Emission Requirements
Based on 2002 Polaris 4-stroke Frontier Engine Dynamometer Test Results (Two Tests with Reference Gasoline)

Mode	hp mi/hr		CO		HC		NOx		PM	
			g/hr	g/mi	g/hr	g/mi	g/hr	g/mi	g/hr	g/mi
Test 1										
1	43.6	65.8	5509.6	83.8	167.65	2.55	228.7	3.48	3.84	0.058
2	18.9	35.1	411.5	11.7	36.17	1.03	123.7	3.53	1.25	0.036
3	10.8	22.2	278.3	12.5	10.77	0.49	38.1	1.72	0.96	0.043
4	5.5	12.9	239.9	18.6	7.6	0.59	9.8	0.76	0.95	0.074
5	0	NA	136.9	NA	34.48	NA	1	NA	0.72	NA
Test 2										
1	44.3	66.5	4729.8	71.1	156.95	2.36	291	4.38	2.61	0.039
2	19.4	35.8	347.2	9.7	27.48	0.77	109.6	3.06	1.15	0.032
3	9.5	20.0	281.6	14.1	12.36	0.62	41.4	2.07	0.94	0.047
4	5.5	12.9	233.1	18.1	6.94	0.54	13.6	1.06	0.79	0.061
5	0	NA	138.2	NA	36.05	NA	1.1	NA	0.35	NA
Average Mode 2, 35 mph		35.5		10.7		0.90		3.29		0.034
Average Mode 4, 15 mph		12.9		18.4		0.56		0.91		0.068
Average Mode 5, Idle			137.6		35.3		1.05		0.54	

Source: Test results: *Laboratory Testing of Snowmobile Emissions*, Lela & White, SwRI July 2002
Speed vs. Power: Personal communication (Privileged and Confidential) from Chris Wright, Arctic Cat, to Aaron Worstell, National Park Service, July 2004

APPENDIX B
CURRENT FLEET SNOWCOACH EMISSIONS FOR MODELING PURPOSES
Composite Emission Factors - Weighted by Yellowstone Fleet Mix

Fleet Average	Idle (g/hr)	Low Speed	Cruise Speed (g/mile)
CO	376.4	227.4	282.9
HC*	29.2	8.4	19.8
NOx	4.1	14.9	15.2

Yellowstone Snowcoach Categories	Number in Commerical Fleet**
Type 1 - Diesel	4
Type 2 - Pre-2000 5.7l V-8 or similar	14
Type 3 - 2000 & later 5.7l V-8	4
Type 4 - 8.1l V-8 or simiar	29
Type 5 - Carburedated 5.7l V-8 Bombardier	26
Type 6 - Fuel-injected 5.7l V-8 Bombardier	3
Total (all types)	80

Note: *HC composite emissions do not include Type 1. HC emissions were not collected for the NPS diesel van sampled.
Weighting assumes all vehicles in the fleet are operated with equal frequency/time period.

**Snowcoaches authorized to operate in Yellowstone, 2005-06 winter.

Sources: Emissions from *Draft In-use Emission Measurements of Snow Coaches and Snowmobiles in Yellowstone National Park*
Bishop, Burgard, Dalton, and Stedman, University of Denver, July 2005
Snowcoach Fleet Information provided by Yellowstone.

Snowcoach Proposed BAT Emissions - Yellowstone National Park

Low-emitting Snowcoach Averages for Modeling Purposes

CO	Idle (g/hr)	Low Speed	Cruise Speed (g/mile)
NPS Van	24.1	8.9	6.2
Xanterra 416	17.3	5.8	94.0
Xanterra 419	50.4	35.0	5.8
Alpen Guides	13.3	7.5	4.9
Average	26.3	14.3	27.7
HC			
Xanterra 416	4.0	0.9	0.8
Xanterra 419	14.0	3.3	0.4
Alpen Guides	4.7	1.4	0.8
Average	7.6	1.9	0.7
NOx			
Xanterra 416	1.4	21.0	27.0
Xanterra 419	0.2	10.0	16.0
Alpen Guides	0.1	1.4	1.4
Average	0.6	10.8	14.8
PM (same as current)			
NPS Van	0.25	0.10	0.12

Note: Proposed BAT emissions are determined by averaging a cleaner subset (3 or 4) of snowcoaches tested.

Source: *Draft In-use Emission Measurements of Snow Coaches and Snowmobiles in Yellowstone National Park*
Bishop, Burgard, Dalton, and Stedman, University of Denver, July 2005

**Yellowstone National Park Snowcoach Emissions
CO**

	Idle (g/hr)	Low Speed (g/mile)	Cruise Speed (g/mile)
NPS Van	24.1	8.9	6.2
Xanterra 163	61.2	88.0	660.0
Xanterra 164	104.4	64.0	490.0
Xanterra 165	540.0	65.0	330.0
Xanterra 166	468.0	360.0	510.0
Xanterra 416	17.3	5.8	94.0
Xanterra 419	50.4	35.0	5.8
Xanterra 709	936.0	580.0	580.0
Alpen Guides	13.3	7.5	4.9
Average/Mean (unweighted)	246.1	134.9	297.9

	Idle (mg/s)
NPS Van	6.7
Xanterra 163	17.0
Xanterra 164	29.0
Xanterra 165	150.0
Xanterra 166	130.0
Xanterra 416	4.8
Xanterra 419	14.0
Xanterra 709	260.0
Alpen Guides	3.7

Source: *Draft In-use Emission Measurements of Snow Coaches and Snowmobiles in Yellowstone National Park*
Bishop, Burgard, Dalton, and Stedman, University of Denver, July 2005

**Yellowstone National Park Snowcoach Emissions
HC**

	Idle (g/hr)	Low Speed (g/mile)	Cruise Speed (g/mile)
NPS Van	na	na	na
Xanterra 163	32.8	7.0	6.4
Xanterra 164	23.8	5.9	4.9
Xanterra 165	50.4	6.3	4.8
Xanterra 166	54.0	22.0	30.0
Xanterra 416	4.0	0.9	0.8
Xanterra 419	14.0	3.3	0.4
Xanterra 709	46.8	15.0	51.0
Alpen Guides	4.7	1.4	0.8
Average/Mean (unweighted)	28.8	7.7	12.4

	Idle (mg/s)
NPS Van	na
Xanterra 163	9.1
Xanterra 164	6.6
Xanterra 165	14.0
Xanterra 166	15.0
Xanterra 416	1.1
Xanterra 419	3.9
Xanterra 709	13.0
Alpen Guides	1.3

Source: *Draft In-use Emission Measurements of Snow Coaches and Snowmobiles in Yellowstone National Park*
Bishop, Burgard, Dalton, and Stedman, University of Denver, July 2005

**Yellowstone National Park Snowcoach Emissions
NOx**

	Idle (g/hr)	Low Speed	Cruise Speed (g/mile)	
NPS Van	57.6	42.0	47.0	
Xanterra 163	9.4	38.0	24.0	
Xanterra 164	3.2	27.0	17.0	
Xanterra 165	2.9	21.0	15.0	
Xanterra 166	1.1	28.0	22.0	
Xanterra 416	1.4	21.0	27.0	
Xanterra 419	0.2	10.0	16.0	
Xanterra 709	1.1	9.4	7.0	
Alpen Guides	0.1	1.4	1.4	
Average/Mean (unweighted)	8.6	22.0	19.6	

	Idle (mg/s)
NPS Van	16.0
Xanterra 163	2.6
Xanterra 164	0.9
Xanterra 165	0.8
Xanterra 166	0.3
Xanterra 416	0.4
Xanterra 419	0.1
Xanterra 709	0.3
Alpen Guides	0.0

Source: *Draft In-use Emission Measurements of Snow Coaches and Snowmobiles in Yellowstone National Park*
Bishop, Burgard, Dalton, and Stedman, University of Denver, July 2005